PROJECTS ■ THEORY ■ APPLICATIONS ■ CIRCUITS ■ TECHNOLOGY

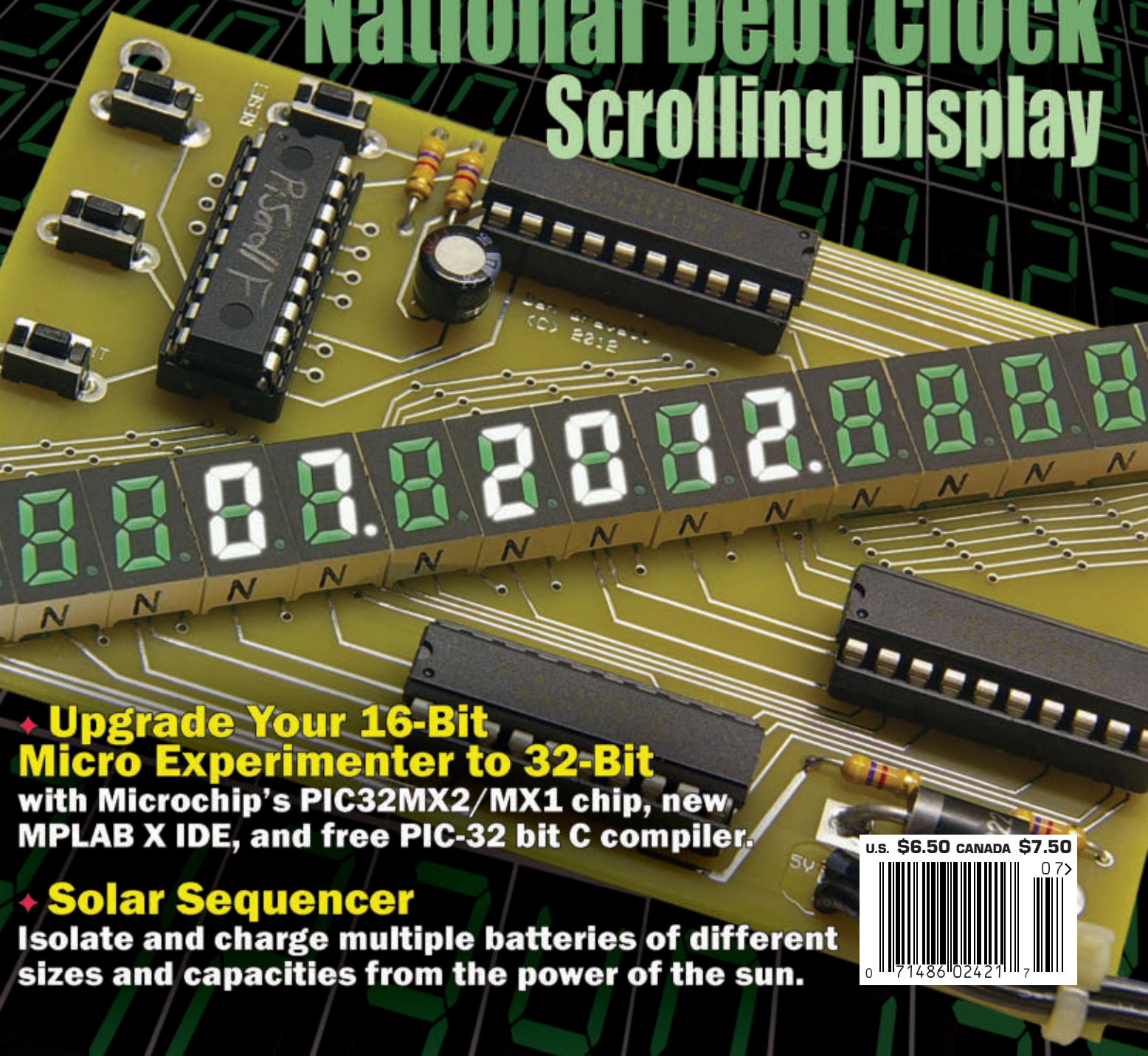
NUTS AND VOLTS

NUTS AND VOLTS

www.nutsvolts.com
July 2012

EVERYTHING FOR ELECTRONICS

Build A Desktop National Debt Clock Scrolling Display



Upgrade Your 16-Bit Micro Experimenter to 32-Bit

with Microchip's PIC32MX2/MX1 chip, new MPLAB X IDE, and free PIC-32 bit C compiler.

Solar Sequencer

Isolate and charge multiple batteries of different sizes and capacities from the power of the sun.

U.S. $6.50 CANADA $7.50

07

0 71486 02421 7

The NetBurner SB70LC

$49.00
Qty. 100
SB70LC Board

The complete hardware and software solution

- Low-cost
- 10/100 Ethernet
- Two Serial Ports
- 32-bit Performance
- Digital I/O
- SSH/SSL Option
- Flash Card Ready
- I²C • SPI Interface
- Example applications

$99.00
SB70LC Development Kit

The SB70LC Development Kit

The NetBurner SB70 LC Development Kit is available to customize any aspect of operation including web pages, data filtering, or custom network applications. The kit includes platform hardware, ANSI C/C++ compiler, TCP/IP stack, web server, e-mail protocols, RTOS, flash file system, Eclipse IDE, debugger, and cables. The kit enables you to communicate with peripherals that use SD/MMC Flash Card (including SDHC), SPI, I²C, or the general purpose digital I/O interface. The NetBurner security suite option includes SSH v1, v2 and SSL support.

NetBurner
Networking in One Day!

Board Part Number | SB70LC-100IR
Development Kit Part Number | NNDK-SB70LC-KIT
Information and Sales | sales@netburner.com
Web | www.netburner.com
Telephone | 1-800-695-6828

freescale™
Alliance Member

2012.
Olympic year

Join the winning team!

The spirit of the Olympic Games is to unite all nations. We united all architectures under mikroC™, mikroBasic™ and mikroPascal™ compilers. Despite their differences, all of them share the same IDE and the same libraries, making a brave step out in compiler philosophy.

MikroElektronika
DEVELOPMENT TOOLS | COMPILERS | BOOKS

GET IT NOW
www.mikroe.com

CHANEY ELECTRONICS, INC.

CELEBRATING 43 YEARS

We Offer Over 1,000 Electronic Components!
Our Full Inventory is Available on Our Website
Order Online with our Secure Shopping Cart System

http://www.chaneyelectronics.com/ ($10 Merchandise Minimum)

Orders Must Include Shipping
Toll Free: 1-800-227-7312 **PO Box 4116, Scottsdale, AZ 85261**

Mini Drill Press for PC Boards

Nicely made drill press has 3 selectable speed ranges by way of a belt and aluminum pulleys, plus a variable speed control for each range, and a die cast aluminum base. Has handy feed lever with depth indicator, adjustable head height on heavy duty column, and adjustable collet for bits up to 1/4" diameter. We use this drill press for drilling PC boards here at Chaney Electronics and it is able to make the smallest holes in our PC boards with great accuracy. This compares to mini presses over $200! Operates on 110VAC 50/60Hz. RPM ranges 5000, 6500, and 8500. Size of base 6-3/4" square, max height 6", and maximum throat depth 4-3/8". Brand new in retail box.

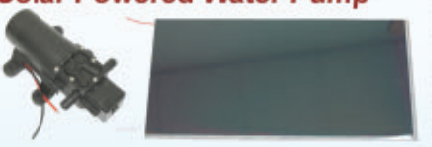
Stock# C17382 **$89.95 ea.**

Ultra Sensitive Giant Geiger Counter Kit

Our largest and most sensitive geiger counter kit uses a Russian Geiger Mueller tube. This tube is 0.75" in diameter x 7.2" long and because of its large surface area it is so senstive to beta and gamma rays that the background count here in Arizona on this kit is about 100 counts per minute. Operates on one 9V battery (not included). Flashes a bright red LED and "clicks" from a small on board speaker with each particle detection. Size of PC board is 7-13/16" x 1-7/16". Complete with all parts, GM tube, and instructions. Requires soldering. No case available.

Stock# C7026 **$149.00 ea.**

Solar Powered Water Pump



Our C7543 pump with this 11.5" x 24" 26V 0.6Amp glass solar panel will pump about 1 gallon per minute while the sun is shining. No hoses or hookup wire included. Just the pump with leads and glass solar panel with short leads attached.

Stock# C7544 **$38.95 ea.**

Flojet 24VDC Demand Spray Pump

Flojet 24VDC demand spray pump is capable of pumping 1 gal per minute (3.8 liters per minute) at a current draw of 1Amp. These develop up to 35PSI and have a built in demand switch to turn itself on/off when discharge valve is open or closed. Self priming -pump can operate dry without damage. Has 3/8" barbs for inlet and outlet. Operates all the way down to 12VDC with slightly less output. Size is 6-3/8" x 2-1/8" (excluding rubber mounting feet). On demand switch can be bypassed if desired. Brand new. Blowout price!

Stock# C7543 **$15.95 ea.**

Electronic Digital Travel Scale

Compact electronic travel scale has a capacity of up to 85 LBs and is perfect for determining if your luggage is under the 50 pound limit. Digital readout can display LBs, KGs, OZs and JINs. Operates on 2 AAA batteries (not included). Size is 2" x 3-2/5" x 3/4".Handy for weighing other items also! Brand new in retail box.

Stock# C7546 **$12.95 ea.**

Our Best Deluxe 25 Piece Gear Assortment

Our best gear assortment contains 25 various gears from small to large sizes with various pitches, shapes, and teeth counts. Great for experimenting or use in robotics. Plastic and metal types. Some may have very unusual shapes!

Stock# C7548 **$12.95/Asst**

10x Jewelers Loupe

Chrome plated jewelers loupe has an 18mm diameter 10x power glass lens. Loupe folds together for compact storage.

Stock# C7541 **$2.49 ea.**

Bourns MF-R185 Resetable Fuse

Nifty fuse by Bourns type MF-R185 (commonly used in car circuitry, RVs, etc) is rated 30V. This fuse trips at 3.7A and then resets automatically when the "short" is removed. Hold current is 1.85A. These really work great and are interesting to experiment with. These look like a disc cap and are about 0.4" diameter x 0.06" thick with 1" long leads. Pricing is typically about 40¢ each. On tape and reel.

Stock# C7549 **5/$1.00**
Factory Reel of 1500
Stock# C7549B **$120.00**

Glass Solar Powered Propeller Kit

This awesome kit requires no soldering. Just push the propeller onto the motor, twist the wires from the round 4" glass solar panel onto the motor terminals and it is ready to go. Great for demonstrating solar power. Whenever sunshine strikes the glass panel the propeller turns! Complete with all parts, pre-wired solar panel and instructions (no case or motor mount included). Great for science fairs, science camps, scouts, etc.

Stock# C7547 **$6.00 ea.**

Allegro Microsystems A3952SB Full-Bridge PWM Motor Driver IC

Allegro 16 pin DIP type A3952SB is rated 20V ±2Amps. PWM current-control. Blowout price!

Stock# C7542 **$1.49 ea.**

Heavy Duty Small 12VDC Motor

Small 12VDC motor features 3600 RPM at 60mA current draw (non-loaded). Size is 1" diameter x 1.7" long (excluding shaft). Shaft is 0.5" long x 2.3mm (0.09") diameter. Motor has a removable metal band around its body.

Stock# C7545 **$0.69 ea.**

"Flickering Candle" Yellow LED with Lens

Small 5mm LED has built in IC to cause it to "flicker" like a candle. Has frosted lens and PC leads. Operates on 3VDC at 10mA.

Stock# C17848 **$1.25 ea.**

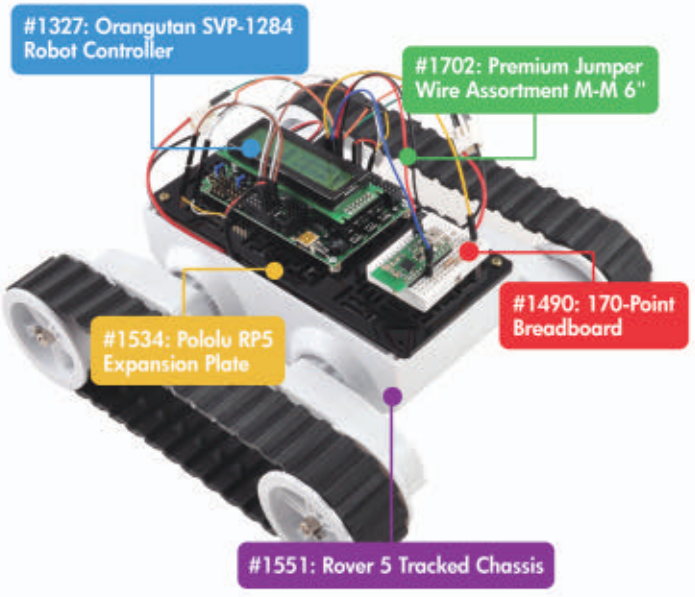
Heavy Duty 20" 10 Piece Alligator Clip Lead Set

Set of 10 heavy duty insulated alligator clip leads. Each clip lead is 20" long and has an alligator jaw clip on each end. Package has 5 assorted colors and 10 leads total.

Stock# C17686 **Reg $2.49 ea.**

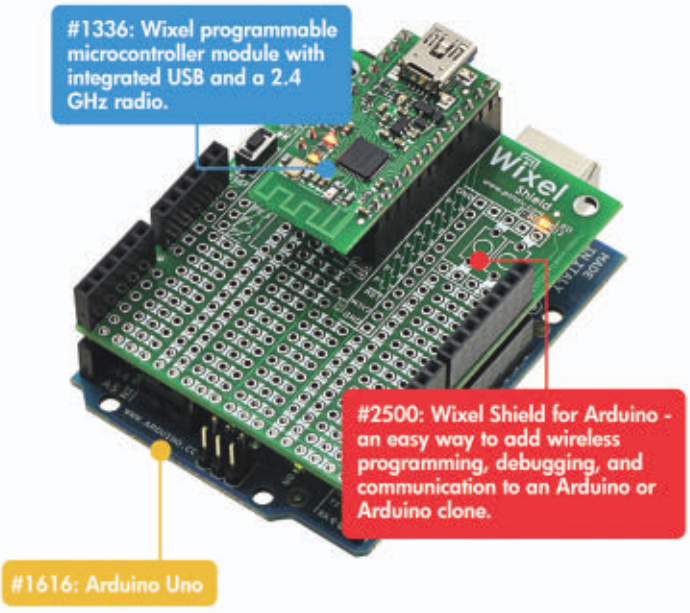
DIY Projects:

Simple Tracked Robot


#1327: Orangutan SVP-1284 Robot Controller
#1702: Premium Jumper Wire Assortment M-M 6"
#1490: 170-Point Breadboard
#1534: Pololu RP5 Expansion Plate
#1551: Rover 5 Tracked Chassis

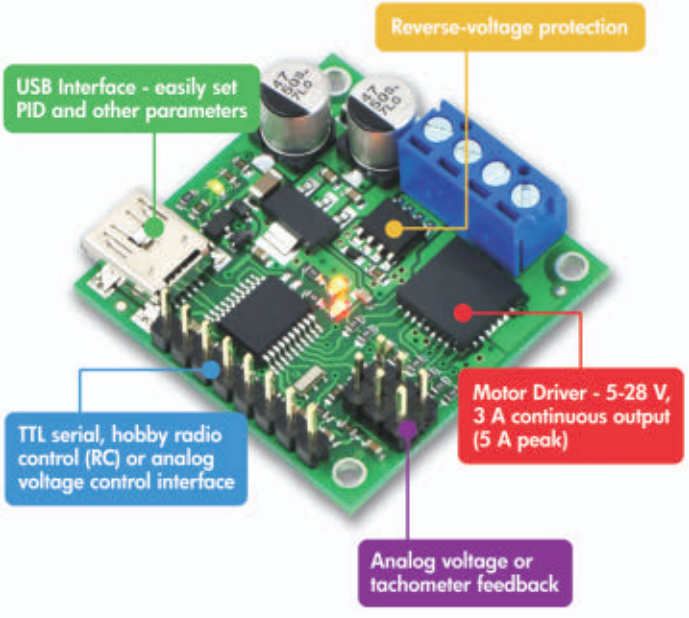
Programmable Controllers:

Wixel and Wixel Shield


#1336: Wixel programmable microcontroller module with integrated USB and a 2.4 GHz radio.
#2500: Wixel Shield for Arduino - an easy way to add wireless programming, debugging, and communication to an Arduino or Arduino clone.
#1616: Arduino Uno

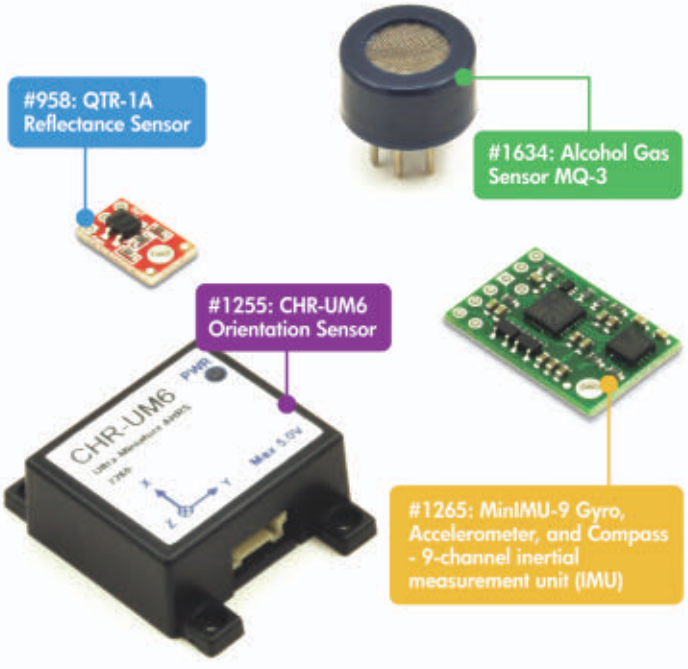
Motor Controllers:

Item #1392: Jrk 21v3 USB Motor Controller with Feedback


Reverse-voltage protection
USB Interface - easily set PID and other parameters
Motor Driver - 5-28 V, 3 A continuous output (5 A peak)
TTL serial, hobby radio control (RC) or analog voltage control interface
Analog voltage or tachometer feedback

Sensors:

Orientation, Reflectance and More


#958: QTR-1A Reflectance Sensor
#1634: Alcohol Gas Sensor MQ-3
#1255: CHR-UM6 Orientation Sensor
#1265: MinIMU-9 Gyro, Accelerometer, and Compass - 9-channel inertial measurement unit (IMU)

Finding the right parts for your robot can be difficult, but you also don't want to spend all your time reinventing the wheel (or motor controller). That's where we come in: Pololu has the unique products - from actuators to wireless modules - that can help you take your robot from idea to reality.

Pololu
Engage Your Brain

Find these products and more at **www.pololu.com**

July 2012

www.nutsvolts.com

Projects & Features

Page 31

31 Build the Solar Sequencer
This innovative system lets you charge multiple batteries of different sizes and capacities while keeping them isolated from each other ... all from the power of the sun.
■ By John Guyer

36 Build the Pi Scrolling Display
This versatile display lets you have your pi and see it, too! With 15 available digits, you can also use it to create your own desktop National Debt clock. (Of course, that may make you lose your appetite.)
■ By Dan Gravatt

42 Streamline Your Home Studio With a Sound Card Switcher
Get to the business of making music instead of messing with cords with this extremely useful and simple device. Makes a great beginner's project too!
■ By Thomas Henry

46 Upgrade Your 16-bit Micro Experimenter to 32-bit for 16x2 Processing Power
With Microchip's PIC32MX2/MX1 chip and the new MPLAB X IDE and free PIC32-bit C compiler, you can easily transition your 16-bit Experimenter to 32-bit processing.
■ By Thomas Kibalo

Columns

10 TechKnowledgey 2012
Events, Advances, and News
Read about the world's largest digital camera, gigabit Wi-Fi, digital drinking, and the death of an industry pioneer ... plus some other interesting stuff.

14 The Spin Zone
Adventures in Propeller Programming
Track 'em Danno!

22 Q & A
Reader Questions Answered Here
Answers to questions on three-phase motor control, digital clocks, and multi-input A/V switches are some of the topics covered this month.

54 Smiley's Workshop
Programming • Hardware • Projects
It's About Time.

68 Near Space
Approaching the Final Frontier
A New BalloonSat Airframe Design.

Page 10

Departments

08	DEVELOPING PERSPECTIVES	64	NV WEBSTORE
09	READER FEEDBACK	67	ELECTRO-NET
28	NEW PRODUCTS	77	CLASSIFIEDS
30	SHOWCASE	78	TECH FORUM
		81	AD INDEX

FUNdamentals For Beginners

76 Build a Screaming Box

Nuts & Volts (ISSN 1528-9885/CDN Pub Agree #40702530) is published monthly for $26.95 per year by T & L Publications, Inc., 430 Princeland Court, Corona, CA 92879.
PERIODICALS POSTAGE PAID AT CORONA, CA AND AT ADDITIONAL MAILING OFFICES.
POSTMASTER: Send address changes to **Nuts & Volts, P.O. Box 15277, North Hollywood, CA 91615** or Station A, P.O. Box 54, Windsor ON N9A 6J5; cpcreturns@nutsvolts.com.

Global® Specialties
www.Globalspecialties.com
Phone: 1-800-572-1028

The **DL-030 Microprocessor Design Trainer**

Whether you're new to designing with FPGA, need to train others about FPGA, or new to implementing microcontrollers in FPGAs, this trainer will accelerate your design process.

GSPA SOP-8B
8-Pin SOP to Through - Hole Prototyping Adapter

GSPA TSOP-48S
48-Pin TSOP to Through - Hole Prototyping Adapter

GSPA PLCC-44
44-Pin PLCC to Through - Hole Prototyping Adapter

GSPA-K1
5-pin DIN connector housed on a PC board

Offer Selection of Over 18 DIY Educational Kits

Courseware
Our courseware offers many options to aid in electronics training and lab instruction.

PB-503 Analog & Digital Design Workstation

NEW

A robust electronics trainer suitable for all levels of electronics instruction and design.

Surface Mount Device Soldering & Re-Work Tool Kit

The set includes 11 tools commonly used for working with surface mount components

Basic Fixed Test Leads
model# CT3737

Provides users with the basic connection leads to begin using one's digital multimeter (DMM)

RDB-10 Resistance Decade Box
A compact, convenient tool for aiding in engineering design and testing as well as calibration of test equipment.

PRO-S Lab
Breadboard with External Power & Jumper Wires

DEVELOPING PERSPECTIVES

When Less is More: Designing for Minimum Mass

If you're a typical *N&V* reader, then sizing a component means defining its value, precision, power handling capacity, operating voltage, physical size, and precision. Take a typical carbon film resistor listed in the Mouser catalog (**www.mouser.com**) — a 2K ohm 1/4W 5% tolerance with axial leads. Although you may not have noticed in the past, if you download the full datasheet, you'll see that the mass is about 226 mg per resistor. Now, go to the equivalent SMT resistor. You'll see mass listings from 2-16 mg, depending on SMT size.

To be fair, the mass of the axial resistor includes the full lead, but we're still talking at least an order of magnitude difference in mass. If you look carefully at the datasheet for most components, you'll find the mass values. Unfortunately, most parts search engines don't allow you to compare component mass.

Why does this matter? Because there are situations where mass really makes a difference. Take micro R/C work, such as my in-progress micro-quadcopter. Every gram saved translates directly to greater maneuverability, longer flight time, and the ability to provide more functionality in the same space. As such, SMT components rule.

So, if you're planning a move to the micro world, what are some additional means of shaving weight? Second to component selection on my list is mechanical connectors. Substitute nylon nuts, bolts, and washers for your sturdy (but massive) stainless steel hardware. Just make certain you're within the safety limits of the holding capacity of the nylon hardware. (See my previous editorial on where to find specs on hardware.)

My third-tier approach is to minimize or discard all electrical connectors. Use micro-connectors instead of full-sized ones. For example, I'm a fan of the JST connector for all of my power connections. SparkFun (**www.sparkfun.com**) sells these little gems which are rated at 100V at 2A AC/DC for $1. These connectors save space, as well as mass. Unfortunately, the datasheet doesn't list the mass, but it's essentially zero compared with typical Molex power connectors.

Related to minimizing connector mass, I also work to minimize the mass contribution of wiring. This means using a PCB tracing instead of wire when possible. Short of that, I use my lookup table of wire gauge vs. maximum handling current. For most of my short runs, I've found that 36 gauge wire-wrap wire works for all of my signal level needs. I sometimes double-up on power runs, using two 36 gauge wires in parallel to handle modest 5V demands — especially when powering a few ICs. Motors and other heavy draw devices get the usual treatment.

My last tactic for minimizing the mass footprint of a device is to modify or replace the supporting structure. For example, I use an electric drill to pepper holes into aluminum sheet metal. When that isn't feasible, I sometimes replace metal with plastic or even carbon fiber, depending on the application. I recently replaced the aluminum spars on my UAV prototype with carbon fiber tubing for a mass reduction of about 10% in the overall structure. Carbon fiber tubing isn't terribly expensive, but be sure to use a composition that provides adequate strength and stiffness. Aluminum tubing often bends when overstressed; graphite tends to shatter. My favorite source for

Dimension Engineering
Sabertooth 2x60
Dual 60A Continuous
Brushed Motor Controller
Specifications:
- 60A Continuous, 120A peak current
- 6V - 33.8V input voltage range (8s lipo max)
- Analog, RC (PWM), and Serial Interface
- Overcurrent, overvoltage, undervoltage, and overheat protection built in
- Fan cooling keeps the controller cool
- Heavy duty terminals take up to 2 gauge wire
- 1 year warranty on every Sabertooth
- DEScribe Software Suite Compatable
ONLY
$189.99
www.dimensionengineering.com/Sabertooth2x60.htm · 899 Moe Dr. #21 Akron, OH 44310 · 330-634-1430

NUTS AND VOLTS
EVERYTHING FOR ELECTRONICS

Published Monthly By
T & L Publications, Inc.
430 Princeland Ct.
Corona, CA 92879-1300
(951) 371-8497
FAX **(951) 371-3052**
Webstore orders only **1-800-783-4624**
www.nutsvolts.com

Subscriptions
Toll Free **1-877-525-2539**
Outside US **1-818-487-4545**
P.O. Box 15277
North Hollywood, CA 91615

FOUNDER/ASSOCIATE PUBLISHER
Jack Lemieux

PUBLISHER
Larry Lemieux
publisher@nutsvolts.com

ASSOCIATE PUBLISHER/ VP OF SALES/MARKETING
Robin Lemieux
display@nutsvolts.com

EDITOR
Bryan Bergeron
techedit-nutsvolts@yahoo.com

CONTRIBUTING EDITORS
Jeff Eckert
Joe Pardue
Paul Verhage
John Guyer
Thomas Henry
Russ Kincaid
Jon Williams
Tom Kibalo
Dan Gravatt

CIRCULATION DEPARTMENT
subscribe@nutsvolts.com

SHOW COORDINATOR
Audrey Lemieux

MARKETING COORDINATOR WEBSTORE
Brian Kirkpatrick
sales@nutsvolts.com

WEB CONTENT
Michael Kaudze
website@nutsvolts.com

ADMINISTRATIVE ASSISTANT
Debbie Stauffacher

PRODUCTION/GRAPHICS
Shannon Christensen
Sean Lemieux

Copyright © 2012 by T & L Publications, Inc.
All Rights Reserved
All advertising is subject to publisher's approval. We are not responsible for mistakes, misprints, or typographical errors. *Nuts & Volts Magazine* assumes no responsibility for the availability or condition of advertised items or for the honesty of the advertiser. The publisher makes no claims for the legality of any item advertised in *Nuts & Volts*. This is the sole responsibility of the advertiser. Advertisers and their agencies agree to indemnify and protect the publisher from any and all claims, action, or expense arising from advertising placed in *Nuts & Volts*. Please send all editorial correspondence, UPS, overnight mail, and artwork to: **430 Princeland Court, Corona, CA 92879**.

Printed in the USA on SFI & FSC stock.

graphite and other exotic lightweight building materials is Kite Builder (**www.kitebuilder.com**). Make sure to check out their chart of weight vs. relative stiffness for their products. Another source for lightweight components, connectors, and 4-40 nylon hardware in bulk is Tower Hobbies (**www.towerhobbies.com**). They're also a good source for R/C airplanes and helicopters — great subjects for teardowns to learn about designing for minimum weight.

Good luck with your own weight loss program. **NV**

READER FEEDBACK

Consistent Color Coding

Bryan Bergeron's perspective on color coding got my attention. I tend to do the same thing documenting my stuff, not that I build much right now. However, I wanted to give a little info as to why bombs are color coded the same way every time.

This was learned — the hard way — during WW II. The Germans — who are very methodical — taught the rest of us that if we do not want to blow ourselves up with our own bombs when we have to defuse them, to ALWAYS color code the connections/ wires the same. ALWAYS.

The quoted life expectancy in Britain during WW II for the men who defused unexploded bombs from German planes was six weeks. They lost at least one man on almost every new bomb that was defused. The guy would be yelling which wire he was cutting before he did it so it could be documented before he died because it was highly probable that he'd cut the wrong wire in an unknown situation. Even with the "known" bombs, situations weren't always safe.

So, the bottom line is if you are planning on making more than one of the items that can kill you if you do something wrong, then ALWAYS color code your control wires the same. ALWAYS. This holds true for any device being built now. If you're making more than one, do all the wire color coding the same. It's much easier to troubleshoot that way.

73 de ke3fl,
Phil

Continued on page 53

The Standard for checking Capacitors in-circuit

Good enough to be the choice of Panasonic, Pioneer, NBC, ABC, Ford, JVC, NASA and thousands of independent service technicians.

Inexpensive enough to pay for itself in just one day's repairs. At $229, it's affordable.

And with a 60 day trial period, satisfaction guaranteed or money-back policy, the only thing you can lose is all the time you're currently spending on trying to repair all those dogs you've given up on.

CapAnalyzer 88A

Locate shorted or leaky components or conditions to the exact spot *in-circuit*

Still cutting up the pcb, and unsoldering every part trying to guess at where the short is?

$229

Your DVM shows the same shorted reading all along the pcb trace. LeakSeeker 82B has the resolution to find the defective component. Touch pads along the trace, and LeakSeeker beeps highest in pitch at the defect's pad. Now you can locate a shorted part only a quarter of an inch away from a good part. Short can be from 0 to 150 ohms.

LeakSeeker 82B

Available at your distributor, or call 561-487-6103

Electronic Design Specialists www.eds-inc.com

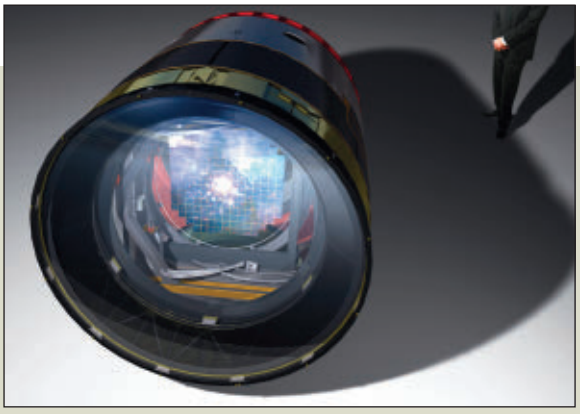
TECH KNOWLEDGEY 2012

EVENTS, ADVANCES, AND NEWS

■ BY JEFF ECKERT

ADVANCED TECHNOLOGY

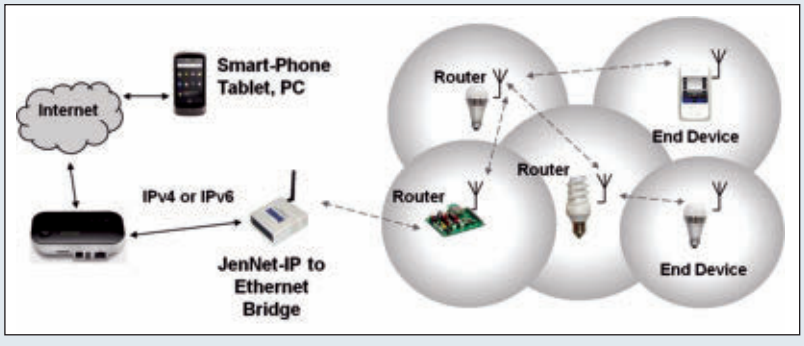
WORLD'S LARGEST DIGITAL CAMERA



■ The LSST camera measures approx. 1.6 × 3 m (5 × 10 ft) and can capture 3.2 billion pixels. *Courtesy of LSST Corp.*

The Large Synoptic Survey Telescope is still in the design and development phase, and full implementation is several years away. However, the goal is to build a facility in northern Chile that will photograph the entire sky every week via a wide-field reflecting telescope, capturing "the widest, fastest, and deepest view of the night sky ever observed." According to a project press release, "Its deep and frequent cosmic vistas will help answer critical questions about the nature of dark energy and dark matter, and aid studies of near-Earth asteroids, Kuiper belt objects, the structure of our galaxy, and many other areas of astronomy and fundamental physics."

At the facility's heart will be an advanced digital camera designed at the SLAC National Accelerator Lab (**www.slac.stanford.edu**) in Menlo Park, CA. The device isn't exactly your typical Canon Sure Shot, as it will be about the size of an average automobile and weigh about three tons. The detector will be made up of a mosaic of 16 Mpixel detectors providing a total of about 3.2 Gpixels. This translates into about six million gigabytes of data per year, which is going to take some pretty serious storage capacity. The camera recently was granted "Critical Decision 1" approval by the DOE which means that the LSST project can move to the engineering design, schedule, and budget phase. If all continues as planned, construction on the telescope will begin in 2014. To follow its progress, visit **www.lsst.org**. ▲



■ Diagram of a JenNet-IP wireless cluster.

CONTROL EVERYTHING FROM YOUR SMARTPHONE

Back in 1999, RFID guru Kevin Ashton coined the term "Internet of Things (IoT)." The concept basically refers to a world in which virtually everything we use on a daily basis has its own Internet address and at least can be tracked and — in many cases — controlled from afar. A decade ago, it seemed like a rather futuristic and complicated concept. But hang on to your hat, because it's coming at us very quickly. One implementation takes the form of the JenNet-IP network software layer, originally developed by Jennic Ltd. JenNet-IP — based on the 6LoWPAN standard — is fully IPv6 compliant and makes it possible to establish two-way communication and control to a network of up to 500 devices, ranging from light bulbs to air conditioning systems in the home.

Two years ago, the company was acquired by NXP Semiconductors (**www.nxp.com**), formerly known as Philips Semiconductors. Not so coincidentally, NXP is a world leader in chip sets for near-field communication and energy management, so there is a logical pairing of its GreenChip technology and smart lighting. Later this year, the company plans to launch a certification program for JenNet-IP and "announce its roadmap for the open source release of JenNet-IP, as well as the retail availability of the first Internet-enabled lamps." What comes after smart bulbs? One can only imagine. A white paper published by Cisco predicts that 50 billion devices will be connected to the Internet by 2020 — more than six times the expected world population. According to Cisco, "As cows, water pipes, people, and even shoes, trees, and animals become connected to IoT, the world has the potential to become a better place." To download the paper, just aim your browser at **www.jkeckert.com/iot.pdf**. ▲

Discuss this article in the *Nuts & Volts* forums at http://forum.nutsvolts.com.

COMPUTERS AND NETWORKING

TABLETS OFFER DISPLAYS UP TO 13 INCHES

■ Toshiba's Excite 13 has the largest tablet display on the market.

The latest news in the tablet market is Toshiba's trio of Android-powered devices, offering a choice of three display sizes: 7.7, 10.1, and 13.3 inches. All feature aluminum shells, Gorilla Glass displays, and NVIDIA Tegra 3 quadcore processors. Each is equipped with a 5 Mpixel camera on the back plus a 2 Mpixel front-facing one for video capture and chatting. You also get stereo speakers, as well as built-in Wi-Fi and Bluetooth connectivity. Even with the oversized display, the Excite 13 is only 0.4 inches thick and weighs 2.2 lb, making it less painful to carry around than one might expect. The 13.3 inch diagonal AutoBrite™ LED Backlit display offers 10-finger touch support, a cinematic 16:9 aspect ratio, and 1600 x 900 resolution, making it suitable for watching HD movies and videos. All come with a suite of Google™ Mobile Service applications, including Google Play™, YouTube™, Gmail™, and Google Maps™. MSRPs run from $499 for the bottom shelf 16 GB, 7.7 in model to $749 for a 64 GB, 13 in one. You can pick one up at a local retailer or from **www.toshibadirect.com**. ▲

■ Netgear's R6300 router provides data transfer rates up to three times as fast as existing 802.11n units.

GIGABIT WI-FI ARRIVES

The IEEE is still working on the new 802.11ac Wi-Fi standard, but there is an old saying that "the IEEE publishes standards in writing only after someone else has published them in hardware." This seems to be the case with the R6300 router from Netgear (**www.netgear.com**) which is the first unit to comply with the 802.11ac specs. This configuration — based on Broadcom's 5GWiFi chips — embraces several enhancements over the common 802.11n standard, allowing data to zip along at up to 1.3 Gbps. Basically, this is because the new standard uses the 5 GHz radio band which offers an 80 MHz bandwidth and more channels than the old 2.4 GHz band. However, the R6300 is a dual-band device, backward-compatible with 802.11a/b/g/n technology, and will still deliver 450 Mbps in the 2.4 GHz band. The company believes that the unit is particularly advantageous with mobile devices, as it allows web content to download faster, and large video and music files to synch more quickly. It should be available by the time you read this, with a retail price of $199.99. ▲

WEB-BASED FINANCIAL ADVICE

If the world of finance makes you feel like the proverbial stranger in a strange land, you aren't alone. It can be daunting to understand the details of 401(k) accounts, mortgages, budgets, and so forth. If you need a little help in achieving your financial goals, a good place to start might be YoBucko (**www.yobucko.com**) — a website billed simply as "your personal finance guide." YoBucko offers articles, videos, and calculators geared toward stepping you through such topics as investing, education, identity theft, car buying, insurance, taxes, and others. The site is the brainchild of Eric Bell, a former investment analyst at the Citi Private Bank. He is backed by half a dozen other financial professionals. In addition to receiving assistance online, you can sign up for a monthly newsletter that "helps you learn how to save money, pay off debt, and build wealth." Best of all, it's free, so drop in and get started. You'll have that 1987 Yugo paid off in no time. ▲

CIRCUITS AND DEVICES

HIGH-PERFORMANCE SURVEILLANCE CAMERA

■ The WatchMaster IP Elite camera provides IR surveillance in adverse conditions.

It's not unusual to see surveillance cameras installed in businesses, schools, government facilities, and other locations that require 24/7 security. However, as we often see in news reports, conventional low light surveillance and security cameras often produce less than stellar images — particularly under adverse weather conditions. One solution is the WatchMaster® IP Elite infrared camera offered by DRS Technologies. According to the company, "The WatchMaster IP Elite detects infrared (heat) waves instead of visible light, allowing it to display a sharp 320 x 240 pixel image through haze, dust, smoke, light fog, and dark of night, conditions that severely limit performance of alternative imaging systems in low light, and other challenging environments. RSTA's infrared technology clearly displays potential threats that would be difficult or impossible to detect with conventional cameras." Traditionally, IR cameras have been too expensive for widespread implementation, but the new DRS model lists at $1,999 for the 40° field of view model, bringing it closer to the price range of conventional low light cameras. The WatchMaster is a fixed-mount, fixed-focus model that conforms to the Open Network Video Interface Forum (ONVIF) standard, so it is compatible with a range of existing security products. The camera supports power over Ethernet (PoE) and consumes less than 15W while running video, camera control, and power over a single tamper-resistant cable connection. For more details, visit **www.drsinfrared.com**. ▲

■ The USB shot glass holds 1 GB of data and a snort of booze.

DIGITAL DRINKING?

If you like to sit at your computer and get drunk at the same time (and who doesn't?), Ali Spagnola has a deal for you. (It isn't totally clear who Ali is, but on her Facebook page — **www.facebook.com/alispagnola** — it says, "Ali Spagnola makes pop art and art pop. She is a drinking composer with a music problem." What Ali has for you is a USB shot glass drive that simultaneously holds 1 GB of data and a couple ounces of your favorite source of inebriation. A nice feature is that the thing is on a lanyard, so if you fall down, you are unlikely to suffer any data loss. But that's not all. Included on the drive is an album of 60 original one minute songs, performed by Ali herself. The playlist includes such gems as "Drinking with a Helmet," "Sandwich in a Can," and "Build a Beeramid." The concept is that you get some friends together (after all, it's not right to drink alone), listen to the album, and drink a shot of beer with every tune, thereby creating a "power hour." All you have to do to get started is visit **www.powerhouralbum.com** and shell out a mere $29.99. Beer not included. ▲

INDUSTRY AND THE PROFESSION

RIP JACK TRAMIEL

■ Jack Tramiel (left) and marketing man Michael Tomczyk celebrate the sale of the one millionth VIC-20 computer, circa 1982.

Those of us who were here during the dawning of the PC age no doubt felt regret at the recent passing of Jack Tramiel at age 83. Jack was the computer pioneer who ran Commodore International which produced the Commodore VIC-20 — a primitive little $300 machine with only 3,583 bytes of usable RAM. In 1982, the VIC-20 became the first computer of any kind to pass the one million sales mark. The company later created the more powerful Commodore 64, of which several million were sold.

All of this is common knowledge, but what many people do not know about Jack is that he was born in Poland as Idek Trzmiel. In 1939 at the age of 11, he and his family were forced into a Jewish ghetto, where he worked in a garment factory. Jack and his family were later sent to the Auschwitz concentration camp. There, he was examined by none other than Dr. Josef Mengele, who sent him and his father to a labor camp near Hanover, Germany. Tramiel was rescued from the labor camp in 1945 by the 84th Infantry Division and two years later, emigrated to the USA. After joining the US Army, he learned how to repair office equipment which set him on the path to founding Commodore. Commenting on how he survived the Holocaust and achieved success, Jack said, "Even if you came out from hell, you can still make it. I like to go forward, not backward ... I live in the future." He will live in history, as well. **NV**

FCC License

ETC
ELKINS TRAINING CO.

Upgrade Your Career in 4 days - Get an FCC License

- Get a **LIFETIME** Federal Communications Commission (FCC) General Radiotelephone Operator License (GROL) with Radar
- Learn the fundamentals of Electronics and Radio Communication
- FCC Licenses are used as hiring and **promotion** standards in many industries
- Master the following **learning objectives:**

• Principles of Radio	• Signals and emission
• Operating procedures	• Antennas and feed lines
• Radio wave propagation	• Principles of Radar
• Electrical principles	• Radar System Types
• Circuit components	• Frequency Bands
• Practical circuits	• Radar Operations

- **The Course**
  - Presented in a step-by-step, easy to follow format
  - 25 hour class; Average 98% pass rate
  - GROL encompasses FCC Elements 1, 3 & 8
  - Tuition includes instruction, fees, books
  - FCC License issuance also included
- **Elkins Training Company**
  - 60 years' experience in technical training, testing, licensing
  - Elkins Institute (dba of BFT Training Unlimited, Inc.) is a national Commercial Operator License Examination Manager (COLEM) for the Federal Communications Commission (FCC)

Call ELKINS for more information (800-821-0906) or (707-792-5678)
email info@elkinstraining.com - www.elkinstraining.com

Save Up T0 60% On Electronic Components

Fantastic New LPC1768 Controller

* Includes LPC1768 Microcontroller with 512kB Flash Memory
* 240 x 320 Color LCD with Touch Screen
* USB, LAN, CAN, SPI, I2C Connections
* Joy-Stick and SD Card Socket

Only $119.90

Save On LED and LCD Panel Meters

* New Digital LED Volt and Amp Panel Meters
* Easy to Read Ultrabright Displays
* No Additional Parts Required
* Ideal for Control Panels and Solar Systems

Starting From Only $8.90

Great New Touch Keypad

* Complete and Ready-To-Run
* Utilizes Capacitive Touch Sensing Technology
* Runs on both 3.3V and 5V power supplies
* Outputs both ASCII and Binary Codes for the Key Pressed

Only $17.90

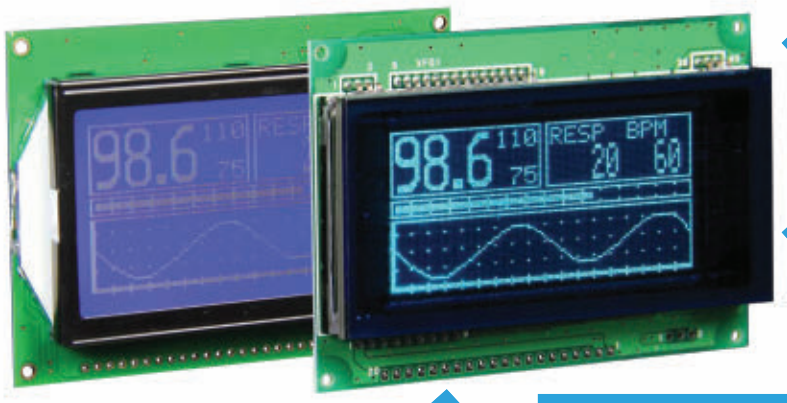
We are your one-stop shop for Microcontroller Boards, PCB Manufacture and Electronic Components

www.futurlec.com

LCD graphic compatible VFD module

http://itron.tv/NV0712
(847) 439-9020

LCD v.s. GU128X64E-U100



Excellent Readability

- Easy to read emissive display
- Wide viewing angle
- Adjustable brightness command
- Quick display response
- Refresh rate of 84 Hz

Features

- KS0108 command compatible
- Serial interface available
- Code library available
- LCD footprint (93mm x 70mm)

Advantages of VFD technology
- Operating temp. -40° to +85° C
- High contrast with color filter

For more information on GU128X64E-U100

Color Filters Available

Noritake itron
The brighter side of electronics
Noritake Co., Inc.
2635 Clearbrook Drive, Arlington Heights, IL 60005

■ BY JON WILLIAMS

Discuss this article in the *Nuts & Volts* forums at http://forum.nutsvolts.com.

TRACK 'EM DANNO!

While many are uncomfortable with the fast pace of technology, for hobbyists like you and me the speed at which things change means that more interesting components become available for us to experiment with. Take the trackball, for example. Now, trackballs have been around for a very long time — remember the monsters used in arcade games? At the leading edge of the smart phone revolution, miniature trackballs were installed in Blackberrys and similar devices. Now, they're available for us to use, too.

In the last Spin Zone column, we did a bit of a reboot and set up some guidelines for writing PASM code that will play nicely with Spin and other languages that run on the Propeller — PropGCC, for example. In this column, I'm going to show you a very practical example of that code style to create a nice little driver for a miniature trackball module. I'm using the module from Parallax (#27908), but the code should run with simple modifications for the button and LED(s) if you're using the SparkFun (COM-09320) board.

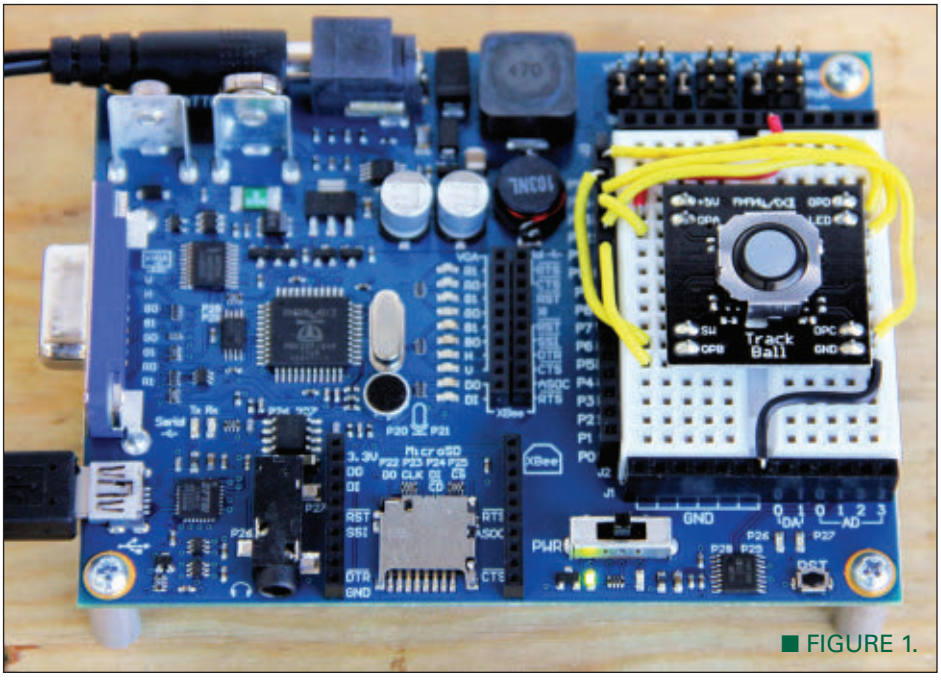
Figure 1 shows my test setup: a Parallax trackball module inserted into the groovy new Propeller Board-of-Education (a fantastic, fully-loaded, yet small platform). The connections for the Parallax trackball are illustrated in **Figure 2**. Note that the direction outputs are labeled OPA, OPB, etc. They map to finger movement on the trackball like this:

```
OPA     Up
OPB     Left
OBC     Down
OBD     Right
```

TRACKIN' THE BALL

The way the trackball works is actually very simple: When there is motion on an axis, the corresponding direction pin will toggle between high and low. I put a 'scope on the pins and found that the delay between edges was never any less than about 2 ms. Could we write a driver in Spin? Probably, but the PASM code for this driver is so easy that we might as well do it that way and take advantage of the speed.

Before we get into the details, though, let's talk about goals. My thought is that a trackball can be treated like an upside-down mouse, and as there is a mouse driver in the Propeller standard library I had a look to see what methods we might want to support. It makes sense to keep the method calls as close as possible to simplify switching between similar devices for an application. Starting with the obvious, we would want to



■ FIGURE 1.

report x and y positions. It might also be useful to report the change from one point to another. Trackballs are often used with graphical output devices, so setting bounds on each axis is probably a good idea, too. Finally, we should probably have a method for resetting the present position and delta values.

CRACKIN' THE CODE

You'll recall that objects tend to use a method called **start**() to get things going, and this method usually accepts one or more parameters for this instance of the object. In the case of the trackball, we have up to six pins that could be used, though only four are mandatory for positions.

From experience, I'll tell you that passing six parameters in a method call can get a little unwieldy, so I have a trick for methods with a lot of parameters: I pass the address of a **DAT** table that holds the required parameters. Let me explain. In the main program, I will, of course, define pin constants for the trackball:

```
con

  TB_LED = 15
  TB_BTN = 14
  TB_DN  = 13
  TB_UP  = 12
  TB_RT  = 11
  TB_LF  = 10
```

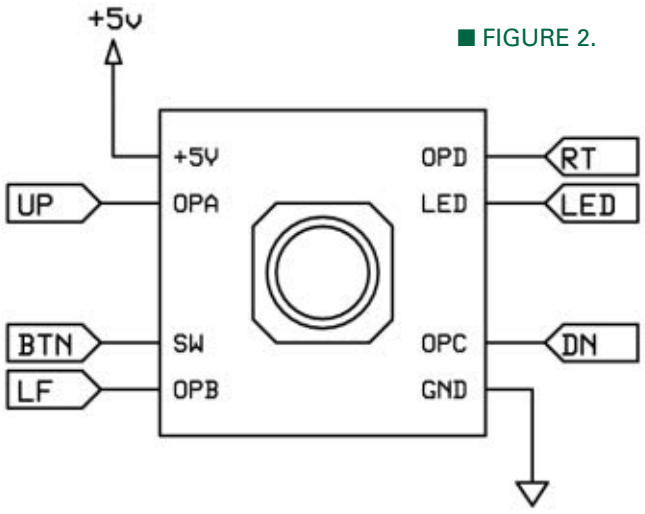
Constants are values used by the compiler and to help make our listings easier to read — they do not have a structure nor address that we can pass as a parameter (i.e., when in a group, we can always pass individual constants by value). We can create a table to pass to an object using a **DAT** section of the code. This is what I've done for the trackball object:

```
dat

TBPins  byte    TB_LF,  TB_RT,  TB_UP,  TB_DN
        byte    TB_BTN, TB_LED
```

Note that the order of the pins in the table corresponds to the requirement set out by the trackball's **start**() method. With this structure in place, we can start the trackball object like this:

```
tb.start(@TBPins)
```

What we're doing is passing a pointer to (*the address of*) the table which takes just one long, instead of all six elements as individual longs (parameters are always passed as longs). I find this helps keep listings orderly and updating pin groupings easier, especially if an object gets started way into the code.



■ FIGURE 2.

Let's get back to building the trackball object. Inside the object, we have the following variables:

```
var

  long  cog
  long  command
  long  cmdparm
  long  btnpin
  long  ledpin
```

Note that we don't have variables for the direction pins; we don't need to save those as they will be used in the PASM cog. The variable *command* will be used to pass a command value to the driver, and *cmdparm* will pass values back and forth based on the command. If the application uses the button input and LED output, they will be handled in Spin methods, so we do have variables to hold those pin numbers. The trackball has four direction output pins and we only have 31 I/O pins on the Propeller. What this means is that we can use a byte per each pin number and pack four bytes into a long for a single hub read of the trackball pins. On the interface side, that happens in the **start**() method:

```
pub start(pinspntr)

  stop

  command := byte[pinspntr][0]
  command |= byte[pinspntr][1] <<  8
  command |= byte[pinspntr][2] << 16
  command |= byte[pinspntr][3] << 24

  btnpin  := byte[pinspntr][4]
  ledpin  := byte[pinspntr][5]

  cog := cognew(@trackball, @command) + 1

  return (cog > 0)
```

After stopping the PASM cog (if it was running), we compress the four direction pins into the command variable, with the left pin sitting in the low byte of *command*.

This code demonstrates the flexibility of Spin when we have a pointer to a variable. Remember that the only parameter used by the **start**() method is a pointer to a pin's definition sitting in a **DAT** table. The first element of that table is element 0, the next is 1, etc. The pointer passed to **start**() is a pointer to a byte. Hence, we use the **byte**[] array to retrieve the values. Of course, we can do the same thing for words and longs; the key is knowing what variable type the pointer is pointing to.

With the direction pins packed into *command,* we can copy the button and LED pins, and then launch the cog. There's a very important note here: In the **cognew** instruction, we are passing the address of *command*, not its contents. Once the PASM cog has a hub address, the contents can be retrieved using the **rdlong** instruction.

At the top of the PASM driver, we make a copy of ***par*** (which is holding the address of *command*), add four to it for the next long (address of *cmdparm*), and save it. The next step is to read the contents of ***par*** which is a long holding the packed pin definitions. You can see below how we can extract each pin and build a mask from it (I'm only showing the first two pins):

```
trackball       mov     t1, par
                add     t1, #4
                mov     paramhub, t1

                rdlong  t1, par

                mov     t2, t1
                and     t2, #$1F
                mov     tblmask, #1
                shl     tblmask, t2

                mov     t2, t1
                shr     t2, #8
                and     t2, #$1F
                mov     tbrmask, #1
                shl     tbrmask, t2
```

After the individual pin masks are created, we will put them all together into a single mask that will be used for sampling the inputs. With the pin's masks created, we can sample the inputs to get the current start of the trackball before initializing the position values and dropping into the main loop:

```
                mov     tballmask, tblmask
                or      tballmask, tbrmask
                or      tballmask, tbumask
                or      tballmask, tbdmask

                mov     oldscan, ina
                and     oldscan, tballmask
```

The interface section of the trackball object provides the following methods that tie into the PASM cog:

```
reset()
abs_x()
abs_y()
delta_reset()
delta_x()
delta_y()
set_bounds()
```

When the code requires more than a few commands, I tend to use the jump table approach in the code. For those of you with BASIC Stamp experience, what I'm about to show you is akin to the **BRANCH** instruction:

```
trackmain       rdlong  cmd, par  wz
          if_z  jmp     #update
                min     cmd, #0
                max     cmd, #8
                add     cmd, #jmptable
                jmp     cmd

jmptable        jmp     #cmdexit
do_cmd1                 jmp     #cmd1
do_cmd2                 jmp     #cmd2
do_cmd3                 jmp     #cmd3
do_cmd4                 jmp     #cmd4
do_cmd5                 jmp     #cmd5
do_cmd6                 jmp     #cmd6
do_cmd7                 jmp     #cmd7
no_cmd          jmp     #cmdexit
```

At the top, we read the command value from the hub and if it's zero (no command), then we'll skip the jump table and update the trackball position values if there was any motion. If a command is present, the first thing to do is ensure that it's legal. We can use the **min** and **max** instructions to truncate an illegal value. The address of the jump table is then added to the command.

Note that in PASM, we use the hash symbol (#) to indicate the address (while Spin uses @). What we have now is an intermediate address in *cmd*; that is, it's to a

RESOURCES

JON "JONNYMAC" WILLIAMS
jon@jonmcphalen.com
www.jonmcphalen.com

PARALLAX, INC.
Propeller chips and programming tools
www.parallax.com

location inside the jump table which is comprised of a number of jumps, each going to the appropriate handler. I know it seems a tad wonky jumping to jumps, but it's very clean and easier to code than compare-and-skip when we have a lot of commands.

For the trackball object, the valid commands are one through seven, so you can see in the table the boundary values of zero and eight jump to an exit point. This simple bit of code clears the command value in the hub which serves as a flag to the interface methods that the command is finished:

```
cmdexit         mov     t1, #0
                wrlong  t1, par
```

Remember that ***par*** is holding the hub address of *command*, so this code is overwriting the last command value with zero.

Before we get to the individual command handlers, let's discuss the working part of the driver: the code that scans the direction inputs and updates position values.

```
update          mov     newscan, ina
                and     newscan, tballmask
                mov     changes, newscan
                xor     changes, oldscan  wz
        if_z    jmp     #trackmain

                test    changes, tbrmask  wc
        if_c    adds    xnow, #1
                maxs    xnow, xmax

                test    changes, tblmask  wc
        if_c    subs    xnow, #1
                mins    xnow, xmin

                test    changes, tbdmask  wc
        if_c    adds    ynow, #1
                maxs    ynow, ymax

                test    changes, tbumask  wc
        if_c    subs    ynow, #1
                mins    ynow, ymin

                mov     oldscan, newscan
                jmp     #trackmain
```

The first step is to grab a copy of the inputs and then mask off all but the direction pins. We then make a copy of the new inputs and **xor** them with the last scan. If there are differences in any of the bits, the exclusive-or process will return a "1" for that input. If there was no change in the inputs (z flag is set) between scans, we can simply jump back to the top of the main loop.

Here's where we need the individual direction pin masks. We will test the bits in *changes* with each mask, and update the appropriate position variable. A change on the right input will increment the x position, and input on the left input will decrement the x position. Similar tests exist for the y position. With the tests complete, the current scan (*newscan*) is saved into the *oldscan* variable for use in the next cycle.

The command handlers are all fairly simple. For example, command one resets the position variables:

```
cmd1            mov     xnow, #0
                mov     xlast, #0
                mov     ynow, #0
                mov     ylast, #0
                jmp     #cmdexit
```

Note that there are current positions and last positions; we need to keep track of the last position so that we can return the delta when requested. Here's how that works for command five, which returns the change (delta) in x position since the last time it was requested or reset:

```
cmd5            mov     t1, xnow
                subs    t1, xlast
                wrlong  t1, paramhub
                mov     xlast, xnow
                jmp     #cmdexit
```

Easy as pie, right? We copy the current position (*xnow*) into *t1*, subtract (using signed subtraction as our position values can be signed) the last marked position (*xlast*), and then write the result to the parameter location in the hub. Finally, we mark the new location by copying *xnow* into *xlast*. Yep, easy as pie.

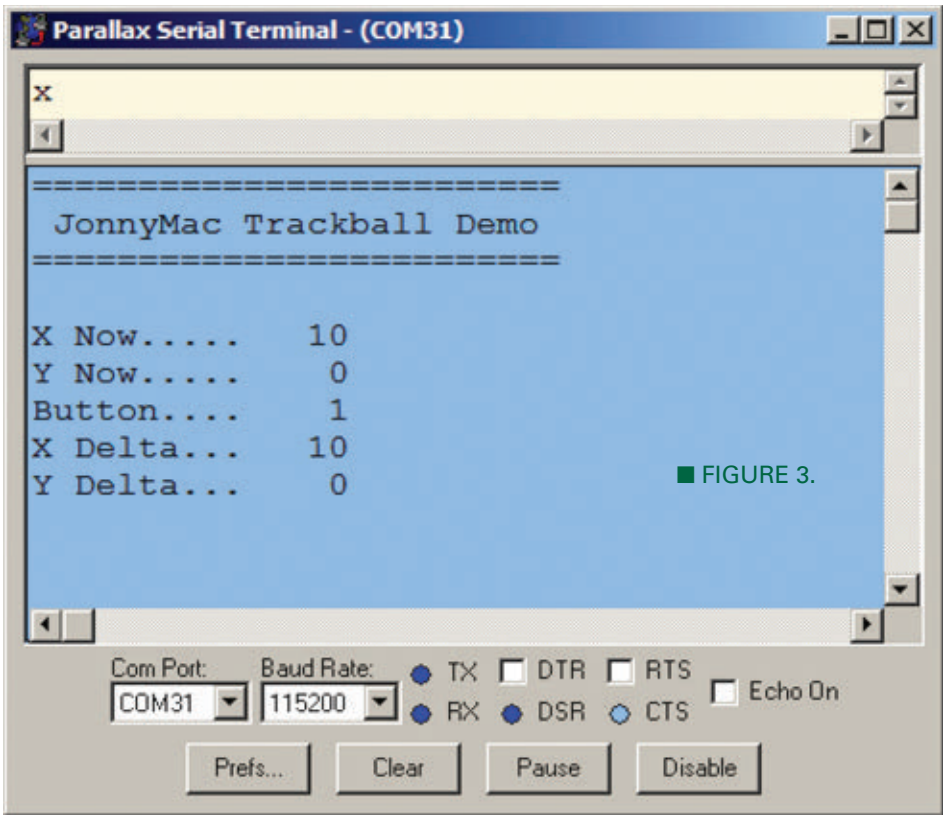
You'll find that the other code handlers are equally simple. Be sure and take a bit of time to explore them as they might come in handy in other objects.

Before we close, I want to show you the top part of the PASM variables. You'll remember from last time that in PASM, we can have initialized and uninitialized variables. For this driver, we have the following set of initialized variables:

```
xmin            long    -100
xmax            long    +100
ymin            long    -100
ymax            long    +100
```

Most of the time, we avoid using initialized variables because they consume space in the hub, but no more than initializing these variables in code. So, pre-initializing makes sense here. And, of course, we need to initialize the boundaries for the trackball driver to work correctly. You might think — as I did in my first version of the driver — that we should use initialized variables for *xnow*, *xlast*, *ynow*, and *ylast*. There is no need because we can simply jump to the **cmd1** handler which clears these values. You'll see in the full listing at the article link that we do this at the very end of the setup code.

Figure 3 shows the output from a little demo program



■ FIGURE 3.

I wrote to test the trackball object. It reports the current position and shows button status. When the button is pressed, the delta values from the last button press are displayed. Pressing the button also lights the LED, so all elements are tested.

So, there we are — a cool little driver for a mini trackball that can be used in myriad applications. I'm just starting to explore graphics on the Propeller, and this is likely where I'll go, though I'm also looking at replacing a standard button interface in an LCD HMI.

What will you do? Have fun, of course, and until next time, keep spinning and winning with the Propeller! **NV**

Custom Front Panels & Enclosures

Sample price $57.32 + S&H

Designed by you using our FREE software, **Front Panel Designer**

- Cost effective prototypes and production runs
- Powder-coated finish and panel thickness up to 10mm now available
- Choose from aluminum, acrylic or customer provided material
- 1, 3 and 5-day lead times available

FRONT PANEL EXPRESS

FrontPanelExpress.com
1(800)FPE-9060

ezPick
VACUUM PICK AND PLACE SYSTEM

ABACOM TECHNOLOGIES
www.abacom-tech.com

ALL ELECTRONICS CORPORATION

QUALITY Parts
FAST Shipping
DISCOUNT Pricing

CALL, WRITE, FAX or E-MAIL for a FREE 96 page catalog.
Outside the U.S.A. send $3.00 postage.

CONTINUITY TESTER

GB Instruments™ Simple continuity tester for all kinds of circuits, switches and fuses. Pointy probe lights when continuity exists. Flexible 34" cable with alligator clip. Requires 2 AA batteries (not included).
CAT# CT-19
$2.95 each

IONIZER

Seawise Industrial Ltd. Model # SW750 Input: 120 Vac. Output: 7.5 KV 60 Hz. The main component in a household ionization unit. 2.2" x 1" x 0.86" thick. UL recognized.
CAT# SW-750
$4.50 each

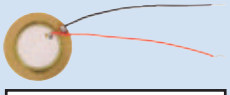
12 VDC XENON FLASHER

Bright strobe assembly with horseshoe flashtube. Approximately 80 flashes per minute. 12 Vdc operation. 65 x 75mm
CAT# FSH-13
$5.50 each

2-CONDUCTOR WEATHER-RESISTANT CONNECTOR

Mating, weather-resistant polarized connectors. 12" red & black 14 gauge stranded wire leads.
CAT# CON-319
100 for $1.75 each
$2.40 each

21MM PIEZO ELEMENT



50mm wire leads.
CAT# PE-56
$1.00 each
10 for 85¢ each

"BED-O-NAILS" TEST LEADS

Insulation-piercing "Bed-o-Nails" alligator clips on sturdy and flexible 14" Neoprene leads, 18 AWG 600V. One red, one black lead with insulating boots on clips. These high-quality leads were removed from new equipment and have a connecting strain-relief near the end which is removable.
CAT# ALG-94
$7.50 each

BUHLER DC GEAR MOTOR

Compact, relatively powerful DC gear motor. 44 RPM @ 6Vdc/ 70mA (no-load rating). 40.0 x 28.5 x 48.5mm long (1.57" x 1.12" x 1.90"), excluding shaft. 3mm (1/8") dia. flatted shaft x 10mm long. 8" pigtail leads.
CAT# DCM-401
$12.50 each

3W 12V SOLAR PANEL

Sealed to withstand hail, snow and wind. Multi-crystalline silicon solar cells in a heavy-duty anodized aluminum frame. High-transparency, low-iron tempered glass. 188 x 195 x 17mm. Junction box with screw or solder terminals. CE.

Specs: Max Power: 3W, Open Circuit Voltage: 21.6V, Operating Voltage: 17V, Operating Current: 0.18A, Short Circuit Current: 0.21A
CAT# SPL-003
$17.95 each

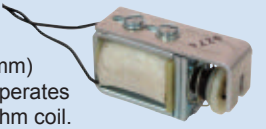
5MW 650NM RED LASER DIODE

LiteOn #LTLD505T. 650nM red laser diode. 2.4-2.6V operation. 3mm dia. case with lens. 6mm dia. gold-plated heatsink base. Gold-plated leads.
CAT# DLM-6
$3.45 each

12 VDC SPST N.O. PC RELAY

MSD Inc (Magnecraft) # 276AXXH-12D. 12 Vdc S.P.S.T., normally-open, pc mount relay. 720 Ohm coil. Contacts rated 10A @ 120/250Vac 30Vdc. 20 x 13 x 10mm (0.78" x 0.50" x 0.38"). PC leads. UL, CSA.
CAT# RLY-557
12 for $1.60 each
$1.75 each

6-12 VDC SPRING-RETURN SOLENOID



1.4" x 1.0" x 0.77" (36.5 x 25.0 x 20.0mm) box-type solenoid operates on 6-12Vdc. 13.8 Ohm coil. 0.32" (7.5mm) diameter plunger has a slot and hole. A nylon bushing and spring on the plunger give the solenoid spring-return capability when a cotter pin or other connecting device is put in the hole in the plunger. An adjustable L-bracket attached to body of solenoid limits the outward travel of the plunger. 9" pigtail leads.
CAT# SOL-137
$2.50 each

AAA NIMH RECHARGEABLE BATTERY

Sanyo "eneloop" 1.2V 750-800mAh rechargeable battery. The key-advantage of the eneloop compared to conventional rechargeable batteries is its extremely low self-discharge. Special purchase.
CAT# NMH-R3
10 for $1.25 each
$1.60 each

12VDC 120MM COOLING FAN

Delta #WFB1212H. 120 x 120 x 26mm. 12 Vdc 0.45A DC brushless cooling fan. Three 12" leads. UL, CSA, CE, VDE.
CAT# CF-406
$4.00 each

Shop ON-LINE www.allelectronics.com
ORDER TOLL FREE 1-800-826-5432

MAIL ORDERS TO:
ALL ELECTRONICS CORP.
14928 OXNARD ST., VAN NUYS, CA 91411-2610

FAX (818) 781-2653 • INFO (818) 904-0524
E-MAIL allcorp@allcorp.com

NO MINIMUM ORDER • All Orders Can Be Charged to Visa, Mastercard, American Express or Discover • Checks and Money Orders Accepted by Mail • Orders Delivered in the State of California must include California State Sales Tax • NO C.O.D • Shipping and Handling $7.00 for the 48 Continental United States - ALL OTHERS including Alaska, Hawaii, P.R. and Canada Must Pay Full Shipping • Quantities Limited • Prices Subject to change without notice.

MANUFACTURERS - We Purchase EXCESS INVENTORIES... Call, Write, E-MAIL or Fax YOUR LIST.

Beat The Heat...Build a Kit!

Ramsey Kits Are Always Cool, Even In The Summer Heat!

Four-Mode Keyless Entry Test Set

- ✔ **Troubleshoot vehicular keyless entry and wireless remote control systems!**
- ✔ **Detects and verifies key fob to vehicle signals as well as vehicle to key fob signals!**
- ✔ **Separate visual indicators for the presence of 315/433MHz, 125kHz, 20kHz and IR signals!**
- ✔ **Can also test virtually any wireless IR/RF control and building access systems!**
- ✔ **Can even test household and home entertainment IR remote controls for the presence of IR signal output!**

Ahh!!... the conveniences of today's technology in our modern world! Voice recognition, LED's instead of incandescent bulbs, on-board computers, on-board hard drives, automatic parallel parking, automatic radar cruise control, and of course, wireless remote controls! They make it so simple, just have the "key" (called a key fob) somewhere in your pocket or purse, get near the vehicle, it knows that you are there! Touch the door handle and the vehicle unlocks. Get in and touch the start button and the vehicle starts. You have yet to use a key through the whole process! And don't forget all the wireless controls for your house lights, building access and entertainment systems. They're so great… until they don't work!

Just like the days of "plugs, points, and condenser" are over, so are the days of having the hardware store grind out a spare key for your car! Now when your keyless access system doesn't work, you need to accurately detect what part of the system is malfunctioning. This could be anything from a dead battery in the key fob, a "brain-dead" key fob, to malfunctioning sensors, antennas, or other system components in the vehicle. The WCT3 is designed for both the car dealer service shops as well as the consumer. Until now there was no way to determine where the system was failing. Please note that the WCT3 simply verifies the generation of the control signals. Indication of signal presence is not an indication the encoded data is valid, nor is it a reader of that code, so don't worry, this will not help anyone steal your car!

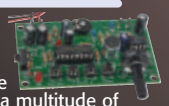
First, let's cover a few basics about vehicular keyless entry. In general, (not all systems are created equal), the vehicle itself generates a signal at 125 kHz or 20kHz. This is the signal that is used to "talk" to your individual key fob. Upon receiving the signal, your key fob "returns" a 315MHz signal uniquely encoded with an identification code and unlock command. If the embedded codes of the vehicle and your key fob match, you're in! Once you have "unlocked" the vehicle, and are inside the vehicle, the presence of your key fob is detected in the same way when the "start" button is pressed. If the codes match, the vehicle can be started. Some manufacturers also use Infrared (IR) signals in their key fobs to add additional user control functions to the vehicle. In that case, the key fob generates a modulated IR signal that is received by the vehicle's IR detectors placed throughout the perimeter of the vehicle.

Testing your system is easy. To test the complete 125 kHz/315 MHz communications path just stand close to the vehicle with the WCT3 and your key fob in hand. Press the test button and the WCT3 will detect and display the presence of the vehicle's 125kHz/20KHz signal and, if they "handshake", will also detect and display the presence of your key fob's 315MHz return signal. You can independently test key fob only signals (panic, lock, trunk, etc.) by holding the key fob near the WCT3, pressing the test button, and pushing the function button on the key fob. The same functionality testing can be done with IR key fobs. The modulated IR signal is detected and will illuminate the IR test LED on the test set. If you know a few "secrets" you can also see if the tire pressure sensors/transmitters are generating signals or the built-in garage door opener in your rear view mirror is transmitting a signal! But the WCT3's uses go beyond the automotive world. The majority of building wireless access systems also utilize 125 kHz. Just hold the test set near the building access sensor and the WCT3 will detect the 125 kHz signal. That will help you troubleshoot door access locations that are not working. It gets even better... you can use the WCT3 to test virtually any other 315 MHz, 433 MHz, 125kHz, 20kHz and IR wireless control system to verify generation of a signal. We should rename this "the handy-dandy, universal, wireless remote control tester"!

The WCT3 test set is housed in a compact 2.25" x 4.6" x 9" case and is powered by a standard 9VDC battery. The test set is available as a do-it-yourself hobby kit or factory assembled and tested. For the kit builder, the WCT3 contains both SMT and through-hole components, with 170 solder points. If you're a car dealer, independent service shop, or simply an owner of a newer vehicle with keyless entry, or have wireless entertainment controls you can't afford not to have a WCT3!

WCT3	**Four-Mode Keyless Entry Test Set Kit**	**$59.95**
WCT3WT	**Four-Mode Keyless Entry Test Set, Factory Assembled & Tested**	**$99.95**

Digital Voice Changer



This voice changer kit is a riot! Just like the expensive units you hear the DJ's use, it changes your voice with a multitude of effects! You can sound just like a robot, you can even ad vibrato to your voice! 1.5W speaker output plus a line level output! Runs on a standard 9V battery.

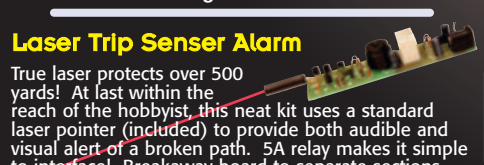
MK171	**Voice Changer Kit**	**$14.95**

Steam Engine & Whistle

Simulates the sound of a vintage steam engine locomotive and whistle! Also provides variable "engine speed" as well as volume, and at the touch of a button the steam whistle blows! Includes speaker. Runs on a standard 9V battery.

MK134	**Steam Engine & Whistle Kit**	**$11.95**

Laser Trip Senser Alarm



True laser protects over 500 yards! At last within the reach of the hobbyist, this neat kit uses a standard laser pointer (included) to provide both audible and visual alert of a broken path. 5A relay makes it simple to interface! Breakaway board to separate sections.

LTS1	**Laser Trip Sensor Alarm Kit**	**$29.95**

Electronic Watch Dog

A barking dog on a PC board! And you don't have to feed it! Generates 2 different selectable barking dog sounds. Plus a built-in mic senses noise and can be set to bark when it hears it! Adjustable sensitivity! Unlike the Saint, eats 2-8VAC or 9-12VDC, it's not fussy!

K2655	**Electronic Watch Dog Kit**	**$39.95**

The Learning Center!

Beginners To Advanced... *It's Fun!*

- ✔ **Learn and build!**
- ✔ **130, 200, 300, & 500 in one electronic labs!**
- ✔ **Practical through hole and SMT soldering labs!**
- ✔ **Integrated circuit AM/FM radio lab!**
- ✔ **Fuel Cell, Solar Hydrogen, and Bio-Energy labs!**
- ✔ **Beginner's non-soldering kits!**

For over 3 decades we've become famous for making electronics fun, while at the same time making it a great learning experience. As technology has changed over these years, we have continued that goal!

PL130A Gives you 130 different electronic projects together with a comprehensive learning manual describing the theory behind all the projects.

PL200 Includes 200 very creative fun projects and includes a neat interactive front panel with 2 controls, speaker, LED display and a meter.

PL300 Jump up to 300 separate projects that start walking you through the learning phase of digital electronics.

PL500 The ultimate electronics lab that includes 500 separate projects that cover it all, from the basics all the way to digital programming.

SP3B Whether young or old, there's always a need to hone your soldering skills. Either learn from scratch or consider it a refresher, and end up with a neat little project when you're done!

SM200K Move up to Surface Mount Technology (SMT) soldering, and learn exactly how to solder those tiny little components to a board!

AMFM108K We not only take you through AM and FM radio theory but we guide you through IC's. When you're done you've built yourself an IC based AM/FM radio that works great!

KNS10 With a reversible PEM fuel cell that combines electrolysis and power conversion into a single device you end up building your own fuel cell car! Learn tomorrows technology today!

KNS11 Learn alternative fuel technology while you build your own H-Racer car and refueling station!

KNS13 Convert ethanol alcohol to run a PEM fuel cell and watch it all work in front of your eyes!

KNS1 A great beginner's kit for the dinosaur enthusiast in the family, young and old! A wooden hobby kit that teaches motor and gear driven operation that requires no soldering.

PL130A	**130-In-One Lab Kit**	**$39.95**
PL200	**200-In-One Lab Kit**	**$84.95**
PL300	**300-In-One Lab Kit**	**$109.95**
PL500	**500-In-One Lab Kit**	**$249.95**
SP1A	**Through Hole Soldering Lab**	**$9.95**
SM200K	**SMT Practical Soldering Lab**	**$22.95**
AMFM108K	**AM/FM IC Lab Kit & Course**	**$34.95**
KNS10	**Fuel Cell Car Science Kit**	**$82.95**
KNS11	**H-Racer & Refueling Station Kit**	**$144.95**
KNS13	**Bio-Energy Fuel Cell Kit**	**$129.95**
KNS1	**Tyrannomech Motorized Kit**	**$17.95**

ramsey
www.ramseykits.com

Where Electronics... Is Always Fun!

- ✔ *Build It!*
- ✔ *Learn It!*
- ✔ *Achieve It!*
- ✔ *Enjoy It!*

Follow Us and SAVE $$

Follow us on your favorite network site and look for a lot of super deals posted frequently... exclusively for our followers!

Digital Controlled FM Stereo Transmitter

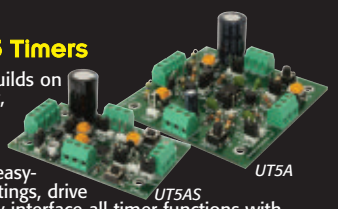
- ✔ PLL synthesized for drift free operation
- ✔ Front panel digital control and display of all set tings and parameters!
- ✔ Professional metal case for noise-free operation
- ✔ EMI filtering on audio and power inputs
- ✔ Super audio quality, rivals commercial broadcasts
- ✔ Available in domestic kit or factory assembled export versions

For nearly a decade we've been the leader in hobbyist FM radio transmitters. We told our engineers we wanted a new technology transmitter that would provide FM100 series quality without the advanced mixer features. They took it as a challenge and designed not one, but TWO transmitters! The FM30 is designed using through-hole technology and components and is available only as a do-it-yourself kit with a 25mW output very similar to our FM25 series. Then the engineers redesigned their brand-new design using surface mount technology (SMT) for a very special factory assembled and tested FM35WT version with 1W output for our export only market!

All settings can be changed without taking the cover off! Enter the setup mode from the front panel and step through the menu to make all of your adjustments. A two line LCD display shows you all the settings! In addition to the LCD display, a front panel LED indicates PLL lock so you know you are transmitting. Besides frequency selection, front panel control and display gives you 256 steps of audio volume (left and right combined) as well as RF output power. A separate balance setting compensates for left/right differences in audio level. In addition to settings, the LCD display shows you "Quality of Signal" to help you set your levels for optimum sound quality. And of course, all settings are stored in non-volatile memory for future use! Both the FM30 and FM35WT operate on 13.8 to 16VDC and include a 15VDC plug-in power supply. The stylish black metal case measures 5.55"W x 6.45"D x 1.5"H. Call for FM35BWT export information. *(Note: After assembly of this do-it-yourself hobby kit, the user is responsible for complying with all FC rules & regulations within the US, or any regulations of their respective governing body. FM35BWT is for export use and can only be shipped to locations outside the continental US or valid APO/FPO addresses or valid customs brokers for end delivery outside the continental US.)*

FM30B **Digital Controlled FM Stereo Transmitter Kit, 0-25mW, Black** **$199.95**

Ultimate 555 Timers



This new series builds on the classic UT5 kit, but takes it to a whole new level! You can configure it on the fly with easy-to-use jumper settings, drive relays, and directly interface all timer functions with onboard controls or external signals.

All connections are easily made though terminal blocks. Plus, we've replaced the ceramic capacitor of other timer kits with a Mylar capacitor which keeps your timings stable over a much wider range of voltages! Available in through hole or surface mount versions! Visit www.ramseykits.com for version details.

UT5A **Through Hole 555 Timer/Osc Kit** **$24.95**
UT5AS **SMT 555 Timer/Osc Kit** **$26.95**

OBDII *CarChip Pro*

The incredible OBDII plug-in monitor that has everyone talking! Once plugged into your vehicle it monitors up to 300 hours of trip data, from speed, braking, acceleration, RPM and a whole lot more. Reads and resets your check engine light, and more!

8226 **CarChip Pro OBDII Monitor-Asmb** **$79.00**

RF Preamplifier

The famous RF preamp that's been written up in the radio & electronics magazines! This super broadband preamp covers 100 KHz to 1000 MHz! Unconditionally stable gain is greater than 16dB while noise is less than 4dB! 50-75 ohm input. Runs on 12-15 VDC.

SA7 **RF Preamp Kit** **$19.95**

Touch Switch

Touch on, touch off, or momentary touch hold, it's your choice with this little kit! Uses CMOS technology. Actually includes TWO totally separate touch circuits on the board! Drives any low voltage load up to 100mA. Runs on 6-12 VDC.

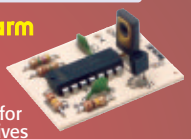
TS1 **Touch Switch Kit** **$9.95**

Doppler Direction Finder

Track down jammers and hidden transmitters with ease! 22.5 degree bearing indicator with adjustable damping, phase inversion, scan and more. Includes 5 piece antenna kit. Runs on 12VDC vehicle or battery power.

DDF1 **Doppler Direction Finder Kit** **$169.95**

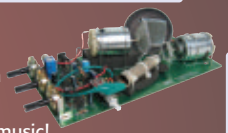
Mad Blaster Warble Alarm



If you need to simply get attention, the "Mad Blaster" is the answer, producing a LOUD ear shattering raucous racket! Super for car and home alarms as well. Drives any speaker. Runs on 9-12VDC.

MB1 **Mad Blaster Warble Alarm Kit** **$9.95**

Laser Light Show



Just like the big concerts, you can impress your friends with your own laser light show! Audio input modulates the laser display to your favorite music! Adjustable pattern & speed. Runs on 6-12VDC.

LLS1 **Laser Light Show Kit** **$49.95**

USB PIC Programmer

Finally, a compact USB PIC Programmer with a 20 pin ZIF socket for easy programming of most Microchip PIC Flash devices that does not require low voltage programming. Plus it uses USB therefore no more RS232 compatibility blues!

CK1301 **USB PIC Programmer Kit** **$34.95**

Water Sensor Alarm

This little $7 kit can really "bail you out"! Simply mount the alarm where you want to detect water level problems (sump pump)! When the water touches the contacts the alarm goes off! Sensor can even be remotely located. Runs on a standard 9V battery.

MK108 **Water Sensor Alarm Kit** **$6.95**

USB DMX Interface

Control DMX fixtures with your PC via USB! Controls up to 512 DMX channels each with 256 different levels! Uses standard XLR cables. Multiple fixtures can be simply daisy chained. Includes Light Player software for easy control. Runs on USB or 9V power.

K8062 **USB DMX Interface Controller Kit** **$67.95**

HV Plasma Generator

Generate 2" sparks to a handheld screwdriver! Light fluorescent tubes without wires! This plasma generator creates up to 25kV at 20kHz from a solid state circuit! Build plasma bulbs from regular bulbs and more! Runs on 16VAC or 5-24VDC.

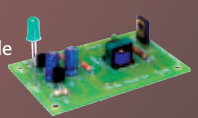
PG13 **HV Plasma Generator Kit** **$64.95**

Air Blasting Ion Generator

Generates negative ions along with a hefty blast of fresh air, all without any noise! The steady state DC voltage generates 7.5kV DC negative at 400uA, and that's LOTS of ions! Includes 7 wind tubes for max air! Runs on 12-15VDC.

IG7 **Ion Generator Kit** **$64.95**

Tickle-Stick Shocker



The kit has a pulsing 80 volt tickle output and a mischievous blinking LED. And who can resist a blinking light and an unlabeled switch! Great fun for your desk, "Hey, I told you not to touch!" Runs on 3-6 VDC.

TS4 **Tickle Stick Kit** **$9.95**

Speedy Speed Radar Gun

Our famous *Speedy* radar gun teaches you doppler effect the fun way! Digital readout displays in MPH, KPH, or FPS. You supply two coffee cans! Runs on 12VDC or our AC125 supply.

SG7 **Speed Radar Gun Kit** **$69.95**

Tri-Field Meter Kit

"See" electrical, magnetic, and RF fields as a graphical LED display on the front panel! Use it to detect these fields in your house, find RF sources, you name it. Featured on CBS's Ghost Whisperer to detect the presence of ghosts! Req's 4 AAA batteries.

TFM3C **Tri-Field Meter Kit** **$74.95**

Passive Aircraft Monitor

The hit of the decade! Our patented receiver hears the entire aircraft band without any tuning! Passive design has no LO, therefore can be used on board aircraft! Perfect for airshows, hears the active traffic as it happens! Available kit or factory assembled.

ABM1 **Passive Aircraft Receiver Kit** **$89.95**

Broadband RF Preamp

Need to "perk-up" your counter or other equipment to read weak signals? This preamp has low noise and yet provides 25dB gain from 1MHz to well over 1GHz. Output can reach 100mW! Runs on 12 volts AC or DC or the included 110VAC PS. Assmb.

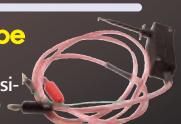
PR2 **Broadband RF Preamp** **$69.95**

Electret Condenser Mic

This extremely sensitive 3/8" mic has a built-in FET preamplifier! It's a great replacement mic, or a perfect answer to add a mic to your project. Powered by 3-15VDC, and we even include coupling cap and a current limiting resistor! Extremely popular!

MC1 **Mini Electret Condenser Mic Kit** **$3.95**

Sniff-It RF Detector Probe



Measure RF with your standard DMM or VOM! This extremely sensitive RF detector probe connects to any voltmeter and allows you to measure RF from 100kHz to over 1GHz! So sensitive it can be used as a RF field strength meter!

RF1 **Sniff-It RF Detector Probe Kit** **$27.95**

3-In-1 Multifunction Lab

The handiest item for your bench! Includes a RoHS compliant temp controlled soldering station, digital multimeter, and a regulated lab power supply! All in one small unit for your bench! It can't be beat!

LAB1U **3-In1 Multifunction Solder Lab** **$134.95**

GET THE NUTS AND VOLTS DISCOUNT!

*Mention or enter the coupon code **NVRMZ12** and receive 10% off your order!*

800-446-2295
www.ramseykits.com

Prices, availability, and specifications are subject to change. We are not responsible for typos, stupids, printer's bleed, or 4th of July fireworks accidents! In the true holiday spirit, Robin made me do this ad copy instead of going out on the boat! Not Fair! Visit www.ramseykits.com for the latest pricing, specials, terms and conditions. Copyright 2012 Ramsey Electronics®, LLC...so there!

RAMSEY ELECTRONICS®
590 Fishers Station Drive
Victor, NY 14564
(800) 446-2295
(585) 924-4560

Q&A

WHAT'S UP:

Join us as we delve into the basics of electronics as applied to every day problems, like:

- ✓ **Three-Phase Motor Control**
- ✓ **Digital Clock**
- ✓ **Multi-Input A/V Switch**

■ WITH RUSSELL KINCAID

In this column, I answer questions about all aspects of electronics, including computer hardware, software, circuits, electronic theory, troubleshooting, and anything else of interest to the hobbyist. Feel free to participate with your questions, comments, or suggestions. **Send all questions and comments to: Q&A@nutsvolts.com**

THREE-PHASE MOTOR CONTROL

Q Can you provide an example of a non-microcontroller based design to invert 644 VDC to 460 volts three-phase AC? This is for a 200 HP, 460 volt, three-phase motor, turning 3,565 RPM. Current is 219 amps. Speed control and reversibility is required, as well.

I know I need to PWM (pulse width modulate) six power MOSFETs or IGBTs, but the control logic to drive these mystifies me.

How was this done prior to microcontrollers? Additionally, can you recommend books that deal specifically with DC to three-phase AC inversion?

— Kenneth C. McGinnis

A To answer your last question first, here are three book titles from **Amazon.com** which you may find useful:

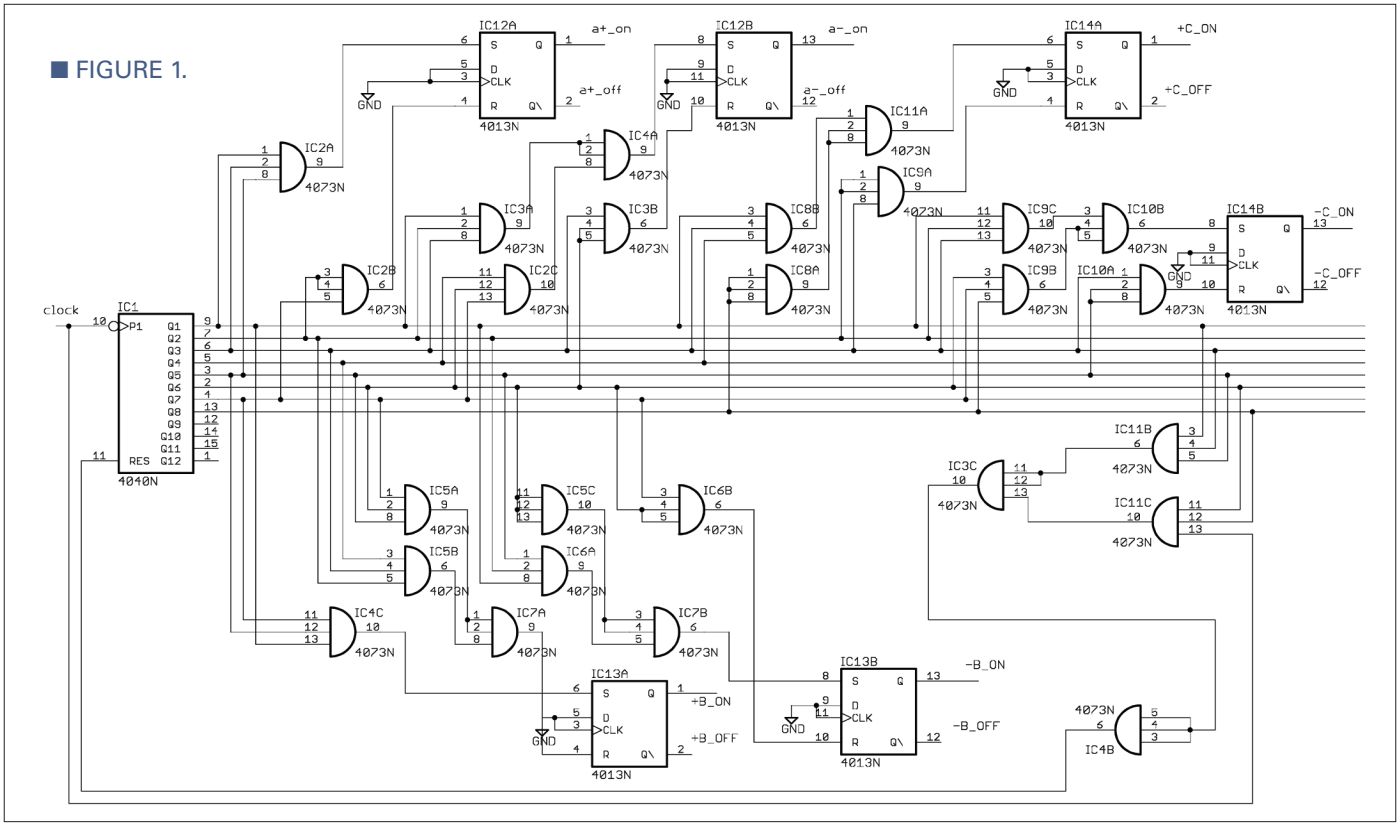
Practical Variable Speed Drives and Power Electronics (Practical Professional Books) by Malcolm Barnes (Aug. 13, 2003).

Electric Motors and Drives: Fundamentals, Types, and Applications (3rd Edition) by Austin Hughes (Nov. 19, 2005).

The Closed-Loop Control of a Three-Phase Inverter Using a DSPACE DS1102 DSP Board by Derek P. Frasz (1998).

The peak-to-peak voltage of 460 VAC is 1,297 volts. You will need a

■ FIGURE 1.



MAILBAG

Dear Russell: Re: PCMCIA Memory Card, April '12, page 23:

With reference to the question from Brent Lamb in the April issue, if all he needs is extra storage instead of USB functions, he should be able to get a Compact Flash-to-PCMCIA adapter for around $5 on eBay. He should be able to use any of the CF cards; well, at least the ones under 2G in size. As far as I remember, CF is actually a PCMCIA device.

— Herbert Tai

There were several versions of the "PCMCIA" style interface, so Brent needs to obtain an adapter that is compatible with his system. The following website explains the differences: **http://en.wikipedia.org/wiki/PC_Card**. It may be easier to find a compatible Compact Flash-to-PCMCIA adapter since they are both parallel standards that share most of their pins. Compact Flash sockets are still available on many new PCs and on USB-to-memory card adapters.

— Bob Lacy

I've located a posting on a machinist website stating that a Sandisk SDAD-38-A10 PC-to-CF card adapter works fine: **www.practicalmachinist.com/vb/cnc-machining/pcmcia-card-new-laptop-184633**. I've used the Transcend CF 2G and 4G Compact Flash with several IDE adapter boards when building FreeNAS NAS (network attached storage), and they work wonderful. Extra Info: **www.practicalmachinist.com/vb/cnc-machining/dnc-fanuc-21i-vmc-186821/**; **www.practicalmachinist.com/vb/cnc-machining/fanuc-pcmcia-compactflash-mem-changes-file-weird-problem-122580/**.

— Larry Kraemer

I can help a little with the PCMCIA-to-USB adapter question. The news is not good though. Most of the machine tools (and some test equipment) use Static RAM (SRAM) cards rather than the more common Flash type. These battery backed-up CMOS cards also use random access addressing, not the ATA hard disk emulation or block write used by PC Flash cards. I've not found an off-the-shelf solution to use either USB memory sticks or CF cards in equipment designed for SRAM cards. A solution would require a controller and enough buffer RAM to store data between block writes to Flash and to compensate for the faster access speeds of the SRAM cards. There is software by ELAN called Memory Card Explorer (**www.pccard.co.uk/copy/aboutmce.php**) that allows reading and writing SRAM cards on a PC, and thus provides a back-up solution. It is not cheap, though.

— Robert G8RPI

A possible solution to the PCMCIA memory card problem is called a PCMCIA CF adapter. This product adapts a Compact Flash (CF) memory card to the PCMCIA slot in the side of old laptop computers. I have a couple of old laptops using these adapters to access 8 GB CF cards. The last time I bought one of these was in 2008. Searching eBay on the quoted string (without the quotes) still returns vendors of this product.

There is a chance that the CF card in the PCMCIA CF adapter will work if the machine tool was using a PCMCIA Flash card. On the other hand, it may not work if the machine was using a really old PCMCIA static RAM card backed up with a coin cell. The reason I say that is because I bought a static RAM card for the PCMCIA slot in a palmtop computer running DOS in 1994. The reason I bought the static RAM was that I had to return a PCMCIA Flash card because the palmtop could not access it. To add insult to injury, in 1996 I found that the static RAM card which worked in the palmtop could not be read in a desktop computer with a PCMCIA slot. The reason was that the desktop was looking for a 16-bit bus, whereas the palmtop could handle the obsolete eight-bit bus used by the static RAM card.

— Dennis Crunkilton

Response: Thanks to all for your interest in this problem. The replies are posted without comment.

full bridge for each phase to operate with 644 VDC (12 transistors). Also, the motor will have to be wound with all three windings brought out individually — not star or delta connected. I will only provide the logic schematic here; whether you choose to use 1,288 VDC with six transistors or 644 VDC with 12 is up to you.

The quasi sine wave that has the same RMS and peak value is positive for 90 degrees, zero for 90 degrees, negative for 90 degrees, and zero for 90 degrees. This is not PWM; you just need a timer and switches to operate at the correct time. **Figure 1** is the timer schematic. The variable frequency clock provides speed control, and reversing one phase will reverse direction. Caution: Reversing a motor while it is going forward may throw it off its mount.

The timer consists of a counter and decoders. I first considered the 4024 seven stage counter but 2^7 = 128 — that is not enough for 360 degrees, so I have to go to the 4040 12 stage counter. I started the count at the first zero crossing but that puts the beginning of the first pulse at 45 degrees, and decoding an odd number requires the clock. I can reduce the number of decode lines by using an even number.

Shifting the phase one degree gives a decode of 44: $2^2+2^3+2^5$. That was okay but at phase B positive turn-off, seven decode lines are required. I want to use triple three-input gates and reasoned that numbers ending in 2 would be better. Sure enough, the decode was reduced to six lines so I went with a phase shift of three degrees. **Table 1** lists the phase values in degrees.

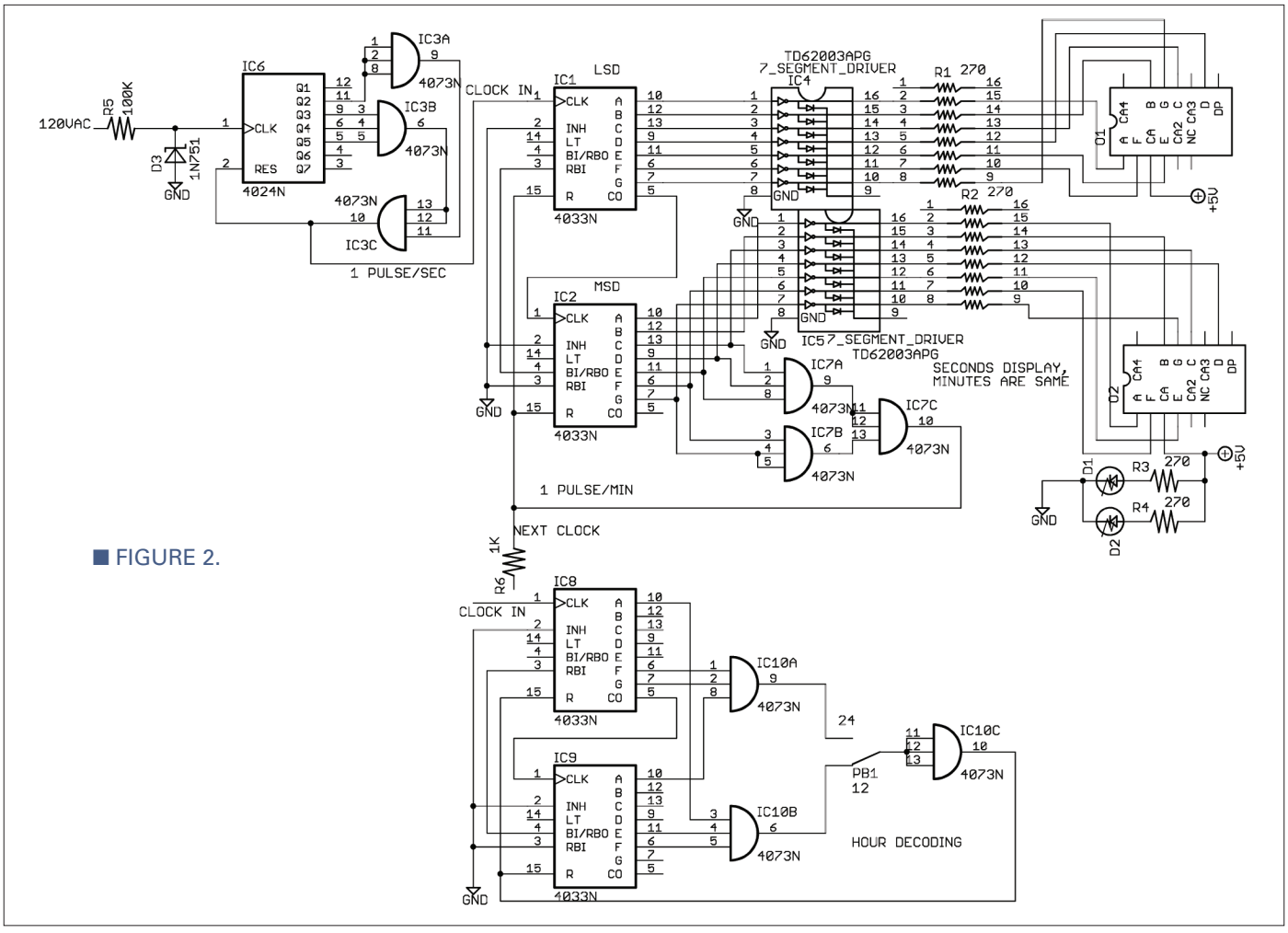
The counter resets every 360 degrees, and the waveform will not be correct until the first cycle has been completed. Considering that all of the ICs in **Figure 1** could be incorporated in one microcontroller or programmable logic array (PLA), do you really want to go this route?

PHASE	POS ON	POS OFF	NEG ON	NEG OFF
A	42	132	22	312
B	162	252	342	72
C	282	12	102	192

Table 1.

DIGITAL CLOCK

Q Recently, I received a beautiful 15-1/2 x 21 inch wooden top that came from a case of wine. I



■ FIGURE 2.

framed it, and it would look great with a seven-segment digital display clock that has hours, minutes, and seconds spread across part of it. Perhaps a red display, about 0.6" in height. I have had several hours of electrical engineering courses at our university, but my field is civil engineering. I've been retired for some time.

The Internet is full of digital clocks but the schematics are complex. Most require multiple circuit boards and two or three voltages from power supplies. I can make a circuit board on a computer running an auto etching machine at school, but not a complex layout.

Could you design a schematic that isn't so complex? Perhaps a PIC or a not-so-complex circuit using non-programmable components? Or, maybe point me in the right direction to find one. It could use the power line frequency or a crystal for accuracy.

— Frank Lemon

I chose to use the CD4033 decade counter with a seven-segment decoder for the clock. CMOS does not have much drive capability, so a Toshiba TD62003APG driver is used. Resistor array R1 and R2 is used for current limiting (270 ohms); see **Figure 2**. The connection from pin 4 of IC2 to pin 3 of IC1 inhibits leading zeros. The display will be 2: 1 instead of 02:01. It is necessary to detect 60 seconds and 60 minutes in order to reset the counter and send a clock pulse to the next stage.

The number 6 uses segments c, d, e, f, and g; when all five are positive, the seconds and minutes are reset. **Figure 2** shows the seconds display; the minutes are identical. The hour display is the same also, but a different decode is needed. The lower part of **Figure 2** shows the decode for 12 and 24 hour display. I didn't decode the whole number because it is only necessary to differentiate between 1 and 2, or 2 and 4. Number 1 uses e and f, and number 2 uses a, b, d, e, and g, but only a is needed to differentiate (could have used b, d, or g also). The number 4 uses f and g. That combination is not used by 1, 2, or 3, so (again) only a is needed to differentiate number 2. The power line frequency is divided by 60 to provide one second pulses to the seconds display. The circuit runs on one 5 VDC supply; a 5 VA transformer should be adequate.

To set the clock, a three-position switch to apply one second pulses to the minutes and hours displays will speed it up. A 1K resistor in series with the clock line will provide isolation from the normal pulse output.

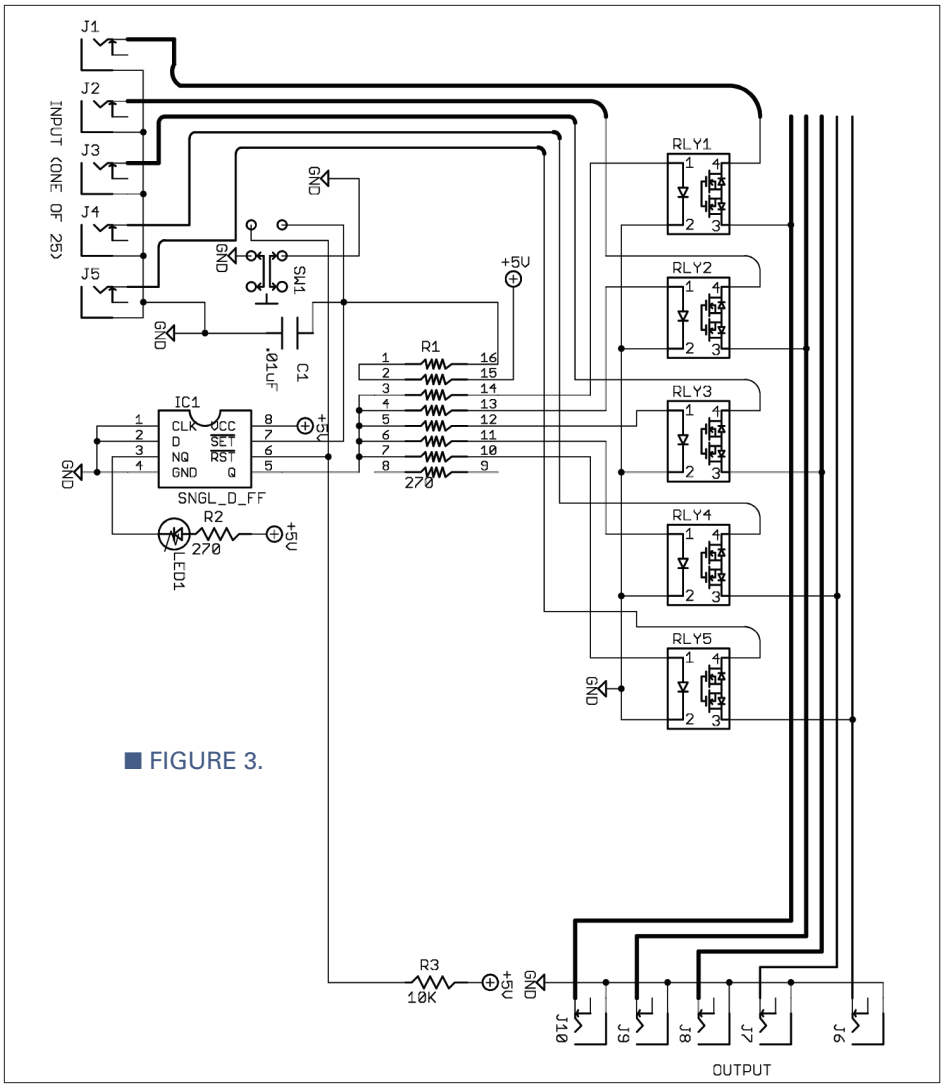
You should be able to make a single-sided layout by using jumper wires where crossovers are needed.

MULTI INPUT A/V SWITCH

Q I have a collection of about 25 different video game systems. I have them all set up and ready to play but I have to "cable swap" every time I want to play a different system. I have a couple of four and six input switchers, but that gets complicated. The cables are composite A/V (red, white, yellow, and stereo audio). What I need is one circuit that can handle all 25 systems. What I would like is one pushbutton next to each system.

When you push the button, it will disconnect any other system that was selected and instead connect the system that is selected. Maybe an LED next to the selected system could be lighted. I have tried relays (my usual method) and PIC chips, but I am unable to figure out how to switch the sheer number of inputs that I need. Perhaps you can help.

— Derek Tombrello



■ FIGURE 3.

A Twenty-five systems times five cables equals 125 signals to be switched to five outputs. My solution (**Figure 3**) uses a flip-flop which when set, enables five solid-state relays to feed signals to an audio/video bus. Flip-flops in the other 124 channels are reset, but the selected is not reset because C1 delays the set signal to insure that the flip-flop ends up in the set state. **Figure 3** shows one channel which is to be repeated 25 times.

I did a preliminary layout to see how big the circuit board would be; I estimate that if half the ports are flipped to the other side of the bus, the board would be three feet by 6-1/2 inches. The board length could be reduced by using three vertical video jacks and two vertical audio jacks, but I did not find any in stock anywhere. **Figure 4** is the Parts List.

The parts are mostly surface-mount except where not available. The RCA jacks need to be thru-hole for robustness and the pushbutton switch is called a "key switch." I don't know what that implies exactly, but I suspect it means you have to press the switch twice to effect a channel change.

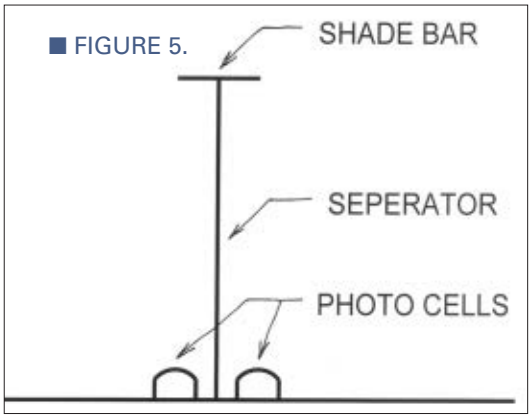
SOLAR TRACKER CIRCUIT

Q Over the years, I have found that the Q & A section of *Nuts & Volts* has always come to my rescue when I needed a circuit to solve a problem. At this time, I need a simple

PARTS LIST FOR VIDEO SWITCH

■ FIGURE 4.

PART	DESCRIPTION	PART #	SOURCE
J1-J10	RCA JACK, THRU HOLE	PJRAN1X1U01X-ND	DIGI-KEY
RLY1-RLY5	SS RELAY, 2 OHMS, 60V	653-G3VM-61D1	MOUSER
SW1	DPDT PUSHBUTTON	642-MHPS2266	MOUSER
R1	8 RESISTOR ARRAY, 270 OHMS	652-CAT16-271J4LF	MOUSER
R2	270 OHMS, 1%, 1/8W, 1206	660-RK73H2BTTD2740F	MOUSER
R3	10K, 1%, 1/8W, 1206	660-RK73H2BTTD1002F	MOUSER
IC1	SINGLE D FF	863-NL17SZ74USG	MOUSER
LED1	0805, SMD, GREEN	604-APT2012SGC	MOUSER



■ FIGURE 5.

solar tracker circuit that I can build. All I need is the electronic part of the circuit; the mechanical part I will work out on my own. I am not familiar with microprocessors, so if possible, can you design or recommend a circuit to fill my need using conventional electronic components? Individual transistors and/or chips are fine. These components, in turn, would activate a relay for switching the tracker motor on and off. This would also be a means of resetting the unit so it will start the next morning, along with limit switches.

— Anonymous

PART	DESCRIPTION	JAMECO PART#
FUSE	250 mA, 250V	103887
FUSE HOLDER	5 MM x 20 MM PANEL MOUNT	102832
T1	12V CT/115 VAC TRANSFORMER	29226
D1, D2	GREEN LED, 2.1V	156962
D3	BRIDGE RECTIFIER, 200V, 1A	103042
C1, C2	1,000 µF, 16V	330722
IC1	QUAD OP-AMP, LM324	212169
Q1, Q2	PHOTOTRANSISTOR	373001
RLY1	DPDT, 6V	2135291
LIMIT SWITCH	SPDT, LEVER ACTION	2117333
D4	DIODE, 1N4148	743285
RESISTORS ARE 1/4 WATT, SIMILAR TO 81832		
MOTOR	6V, 100 mA	253403
MOTOR	6V, 100 mA	167039

PARTS LIST FOR SOLAR TRACKER

■ FIGURE 7.

I once built an antenna servo using LM324 op-amps and 12 volt servo motors; I think that would work here. No relays though; they are too slow. I don't know the mass of the system being moved but I don't think that will matter because it is moving so slow. The system will be way over-damped. The system will need a photo sensor — actually two of them in a balance circuit such that the one with the most light will move in that direction.

Figure 5 shows a possible configuration. The circuit (**Figure 6**) is for Azimuth; if you want elevation, it is the same

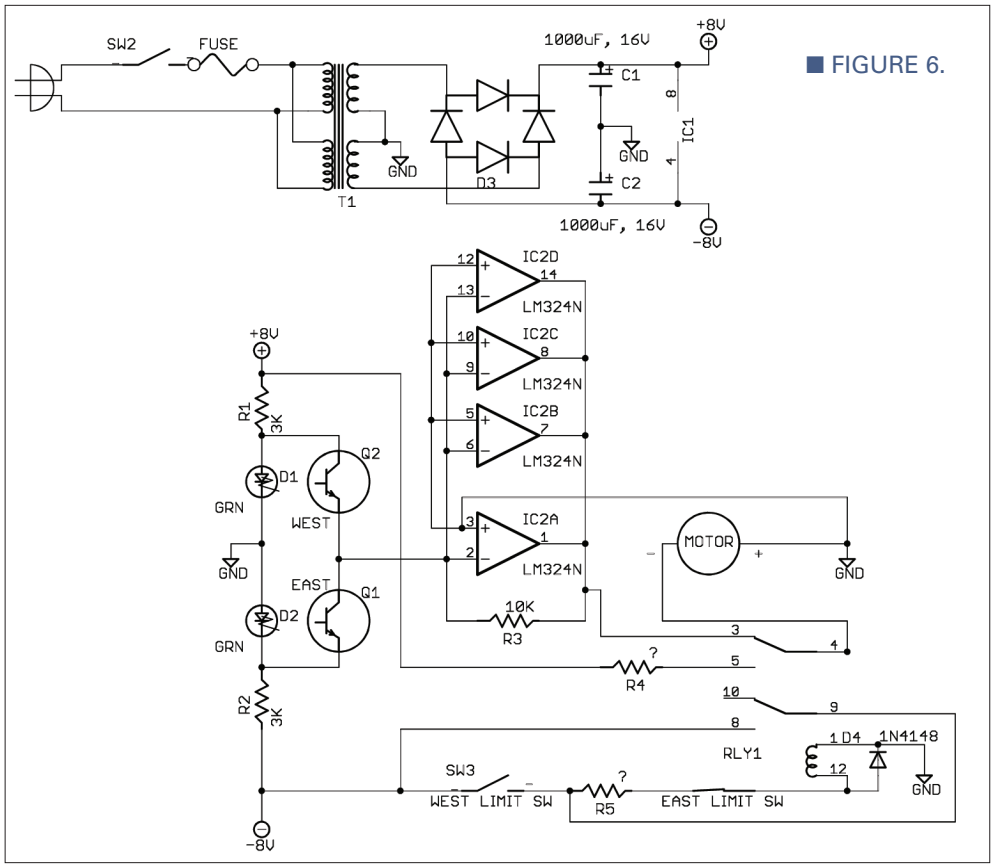
but mechanically at 90 degrees. The Parts List is in **Figure 7**.

When Q1 has more light than Q2, the op-amp output is driven negative which drives the motor forward. If the motor doesn't move fast enough, the gain can be raised by increasing R3.

When the west limit is reached, SW3 closes which latches the relay and connects the motor through R4 to the positive supply which reverses it. R4 is to be selected to limit the motor speed.

It would seem best that the array reach the east limit when it is quite dark, so the phototransistors are inactive. At the east limit, the east limit switch opens and unlatches the relay, leaving the system ready for sunup.

R5 is a limit resistor in case the relay overheats on eight volts (probably not needed). **NV**



■ FIGURE 6.

AP CIRCUITS
PCB Fabrication Since 1984

As low as...
$9.95
each!

Two Boards
Two Layers
Two Masks
One Legend

Unmasked boards ship next day!

www.apcircuits.com

VISA MasterCard PayPal IPC MEMBER ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES BBB

Model 324
WORLD'S MOST VERSATILE
CIRCUIT BOARD HOLDERS
Our line of Circuit Board Holders add versatility & precision to your DIY electronics project. Solder, assemble & organize with ease.
MONTHLY CONTEST
Visit us on Facebook® to post a photo of your creative PanaVise project for a chance to win a PanaVise prize package.
Model 201
PANAVISE®
Innovative Holding Solutions
VISIT US ON
7540 Colbert Drive • Reno • Nevada 89511
1 (800) 759-7535 | www.PanaVise.com

NEW PRODUCTS

- HARDWARE
- SOFTWARE
- GADGETS
- TOOLS

IC CHIP SOLUTION FOR MULTI-CHANNEL OPERATION

Lemos introduces the AXSEM RF IC chip for narrow-band multi-channel operation in licensed and unlicensed bands.

The AX5043 is a single chip narrow-band RF transceiver for the 70 MHz to 1,050 MHz frequency bands. It offers a unique receiver combination of high sensitivity, high selectivity, and ultra-low power. Combined with its high transmit power capability (up to 20 dBm), a link budget of 143 dB is achieved. Only a few external components are required. The AX5043 works perfectly down to 1.2 kbps in a 6.25 kHz channel. Though a TCXO is recommended for such operation, the AX5043 can also be operated with a normal crystal if the necessary precautions are taken into account.

An integrated voltage regulation system allows the direct use of batteries, and short start-up times enable time- and energy-efficient protocols. This makes the AX5043 ideal for battery powered portable applications. The AX5043 features a low power wake-up clock and timer — which typically consume 500 nA — allowing it to autonomously handle wake-on-radio cycling.

The AX5043 supports FSK, MSK, 4-FSK, GFSK, GMSK, and ASK modulations. In transmit mode, all modulations are shaped to meet the most stringent regulatory requirements. Power ramping can be configured without restrictions. Maximum output power levels are 16 dBm at 868 MHz, and 20 dBm at 70 MHz carrier frequency. The configurable packet engine supports a wide range of packet formats that are handled without microcontroller intervention.

The development kit comes with a productivity-enhancing complete development tool suite. The AXSEM development kit DVK-2 is a complete and flexible ready-to-go solution for easy testing, evaluation, and development of AXSEM RF ICs. It is suited for real performance tests, as for application code development.

The DVK-2 is based on the AX8052F100 MCU, and AXSEM offers both the AX-RadioLab GUI as well as the advanced AX8052-IDE, together with the open source and freely usable SDCC compiler.

For more information, contact:
Lemos International
Web: **www.lemosint.com**

NEW FPGA-BASED MICROPROCESSOR DESIGN TRAINERS

Global Specialties has added the new Microprocessor Trainer Model DL-030 to its family of integrated digital logic trainers.

The DL-030 microprocessor trainer utilizes an FPGA chip, allowing a user to implement a fully functioning microcontroller in minutes. The DL-030 is a complete and ruggedly packed trainer that will provide a solid learning platform for individuals and classroom students. With the DL-030, you can create and implement your first design in as little as one hour.

Features include:

- Student trainer lab manual and experiments
- Altera Cyclone® III EP3C16F256C8N FPGA
- USB interface lead
- Software CD
- Breadboard interface lead wires
- Three pushbutton switches
- 16 red user LEDs
- Three seven-segment LED displays
- 16 toggle switches
- Eight-pin general-purpose I/O header
- Vcc and GND connection points
- 270-tip point breadboard
- USB connector for connecting the DL-030 trainer to a development computer

For more information, contact:
Global Specialties
Web: **www.globalspecialties.com**

STM32 ARM TOOLCHAIN

mikroElektronika has a new version of mikroC, mikroBasic, and mikroPascal compilers for ARM® that include 186 new

microcontrollers from STM32, including Cortex™-M3 and Cortex™-M4. mikroElektronika has introduced over 50 libraries and dozens of examples that will get you started quickly. Anyone who already owns compiler licenses can get double the functionality by downloading the new compiler version. Others who don't can evaluate the compilers under the Demo limit to explore the look and feel before deciding to join in. EasyMx PRO v7 for STM32® supports the entire family range of 186 STM32 microcontrollers and is rich with modules.

The onboard mikroProg™ debugger based on ST-LINK v2 will provide a fast debugging and programming interface. The board is delivered with EasyTFT which carries a 320x240px TFT touchscreen. The same connector can be used to place standard GLCD 128x64px. Two mikroBUS sockets enable you to use the fast growing number of popular Click Boards. It is delivered with an MCU card containing STM32F107VCT6.

mikromedia for STM32® boards now has two versions: the mikromedia for STM32® M3 carrying STM32F207VGT6 and the mikromedia for STM32® M4 carrying an STM32F407VGT6 device. Both are equipped with rich multimedia modules and provide a full set of examples and documentation.

mikroProg for STM32® brings ease of use to other mikroElektronika debuggers. It's based on the ST-LINK v2 debugger and will work with mikroElektronika compilers, as well as others. It supports 186 STM32 microcontrollers.

For more information, contact:
mikroElektronika
Web: **www.mikroe.com**

If you have a new product that you would like us to run in our New Products section, please email a short description (300-500 words) and a photo of your product to:
newproducts@nutsvolts.com

2-IN-1 INSULATION TESTER & WIRELESS DATALOGGING COMBO METER

Extech Instruments announces its new MG300 — a true RMS multimeter with built-in insulation resistance tester, and the added safety of wireless datastreaming for remote monitoring and datalogging.

By adding insulation testing capabilities to the ubiquitous digital multimeter, electricians are equipped for insulation testing, helping to make it a more routine part of predictive maintenance, with faster troubleshooting and repairs without additional tools.

The rugged and waterproof (IP67-rated) combination meter includes a digital insulation resistance tester (or megohmmeter) with four different test voltages for measuring resistance up to 4 GΩ with 0.001MΩ resolution. The full-function, true RMS digital multimeter includes useful extras like duty cycle measurements and milliamp readings for analog 4-20 mA current loops in industrial analog process controls.

The CAT-IV-rated meter's wireless datastreaming enables safer troubleshooting and maintenance on dangerous moving equipment and one-person operation of remote safety switches. Technicians can

Continued on page 74

EARN MORE MONEY
Get your dream job!
Be an FCC Licensed Wireless Technician!
Make up to $100,000 a year and more with NO college degree

Learn Wireless Communications and get your "FCC Commercial License" with our proven Home-Study Course!

- No need to quit your job or go to school.
- This course is easy, fast and low cost.
- No previous experience needed!
- Learn at home in your spare time!

Move to the front of the employment line in Radio-TV, Communications, Avionics, Radar, Maritime and more… even start your own business!

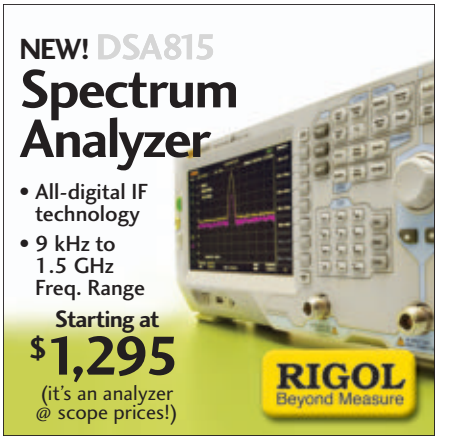
Call now for FREE info
800-932-4268 ext. 209
Or, email us:
fcc@CommandProductions.com

COMMAND PRODUCTIONS
Warren Weagant's FCC License Training
P.O. Box 3000, Dept. 209 • Sausalito, CA 94966
Please rush FREE info immediately!
NAME: _____
ADDRESS: _____
CITY/STATE/ZIP: _____
email: fcc@CommandProductions.com

SHOWCASE

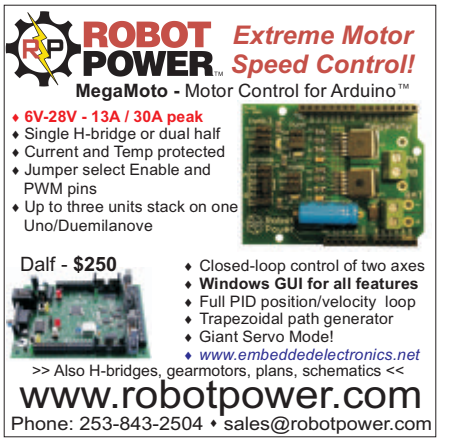
BlinkM
Arduino
I2C RGB "Smart LED"
USB - BT - XBEE
Prototyping Supplies
Serial LCD
FunGizmos.com
RS232, I2C, SPI
Save 5% with coupon code NV
FunGizmos.com

NKC electronics
EVERYTHING ARDUINO!
visit: store.NKCelectronics.com/arduino
Arduino UNO R3 - Arduino Leonardo - Arduino MEGA 2560 R3
Ethernet Shield - Starter Kits - Shields for Arduino - Serial LCD


NEW! DSA815
Spectrum Analyzer
• All-digital IF technology
• 9 kHz to 1.5 GHz Freq. Range
Starting at
$1,295
(it's an analyzer @ scope prices!)
RIGOL
Beyond Measure

Recycling & Remarketing High Technology
WEIRDSTUFF
WAREHOUSE
Software,Computers,Electronics,Equipment,Doohickies
WE BUY/SELL EXCESS & OBSOLETE INVENTORIES
FREE COMPUTER AND ELECTRONIC RECYCLING
GIANT 10,000 SQ. FT. AS-IS SECTION
384 W. Caribbean Dr.
Sunnyvale, CA 94089
Mon-Sat: 9:30-6:00 Sun: 11:00-5:00
(408)743-5650 Store x324
WWW.WEIRDSTUFF.COM

RF Specialists
ZigBee Solutions
ProBee Series
High Performance and Robust Data Transfer Capability
ZigBee Solutions
Low Cost
Low Power
Long Range
LEMOS INTERNATIONAL
www.lemosint.com
866.345.3667
sales@lemosint.com


ROBOT POWER
Extreme Motor Speed Control!
MegaMoto - Motor Control for Arduino™
♦ 6V-28V - 13A / 30A peak
♦ Single H-bridge or dual half
♦ Current and Temp protected
♦ Jumper select Enable and PWM pins
♦ Up to three units stack on one Uno/Duemilanove
Dalf - $250
♦ Closed-loop control of two axes
♦ Windows GUI for all features
♦ Full PID position/velocity loop
♦ Trapezoidal path generator
♦ Giant Servo Mode!
♦ www.embeddedelectronics.net
>> Also H-bridges, gearmotors, plans, schematics <<
www.robotpower.com
Phone: 253-843-2504 ♦ sales@robotpower.com

QKITS.COM
Power Supply: 12/24VDC Load Voltage
30A PWM DC Motor Speed Control
Control the speed of your electric motors or the brightness of your DC light bulbs.
$24.95
Quantity discounts available.
1-888-GO-4-KITS

SDPSI
sdp-si.com
800-819-8900
FREE CATALOG
Small Mechanical Components
SETTING IDEAS INTO MOTION

The 32-Bit Micro Experimenter Board.
Includes Free Software!
Subscriber Discount Available!
For more information and kits, please visit:
www.nutsvolts.com or call 800 783-4624

www.Primecell.com
Battery rebuilding service
Dead Batteries ? Don't toss them.
Send them to us - our rebuilds are better than original specifications.
Tools
Hilti Skil
Milwaukee
Panasonic
B&D DeWalt
Makita All
2-36 Volts
Electronics
Bar Code Scanners
Surveying
Printers
Laptops
Photography
Radios
APELCO
UNIDEN
G.E. ICOM
KENWOOD
MOTOROLA
MIDLAND
MAXON
YAESU
ALINCO
Visit www.primecell.com for important details
24 Hr Secure recorder tel-fax (814) 623 7000
Quotes email: info@primecell.com
Cunard Assoc. Inc. 9343 US RT 220 Bedford PA 15522

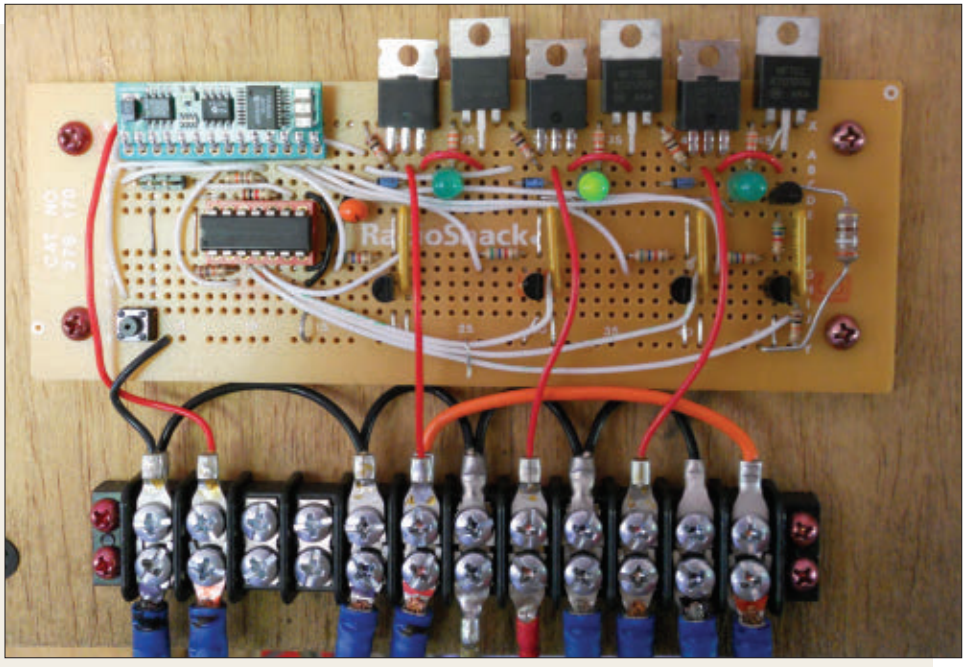
NKC electronics
owon
PREMIUM Distributor
OSCILLOSCOPES
visit: store.NKCelectronics.com/owon
SDS7102V
100 MHz 2-Channel
1 GSa/s Sample Rate
10M Record Length
8" 800x600 TFT Display
USB - VGA - LAN
PDS5022T
25 MHz 2-Channel
100 MSa/s Sample Rate
8" 640x480 TFT Display
USB Interface
HDS1022M-N
20 MHz 2-Channel
100 MSa/s Sample Rate
Handheld with Battery
3.7" 640x480 TFT Display

Do you know how many watts (YOUR MONEY) are going down the drain from "THE PHANTOM DRAW?"
How many Kilowatts does $29.95 buy you?
To order call 1 800 783-4624
or online www.nutsvolts.com

BUILD THE SOLAR SEQUENCER

By John Guyer

This article describes how to build a solar sequencer which enables a single solar panel to charge multiple batteries of different sizes and capacities, keeping them isolated from each other. This article also covers how to use a solar panel and battery to run a garage door opener in a building without access to utility power. The Solar Sequencer provides a maintenance charge to 12 volt lead acid automotive batteries from a 45W solar panel. My unit has been in operation for three years now.



■ **FIGURE 1. Solar sequencer prototype.**

Solar Panel

The solar panels are from Harbor Freight's 45 watt solar panel kit. The panels face due south and are mounted at 30 degree angles to each other in order to spread the capacity over as much of the day as possible. If they are mounted as shown in the kit directions, the current can be over three amps at noon, but not much in the morning and evening. The mount was made out of 1" aluminum angle purchased from the hardware store.

Garage Door Opener

The garage door opener I used is a Craftsman/Chamberlain belt drive with a battery backup. It is designed to run from a 12 volt 5 Ah lead acid battery (included), but only as a backup. Everything but the lights work with no AC power, and it draws about 40 mA when in standby. It does need AC power applied initially, but will work from the battery afterward. I used a long extension cord at first, but switched to a cheap 400 watt modified sine wave inverter to get it started, then disconnected the inverter. This garage door opener uses four amps DC to open the door and 3.5 amps to close it. Both take about 20 seconds.

Battery

The small battery included with the garage door opener only lasts about six months. It is only intended as a backup — not a primary power source. I replaced it with a lead acid battery that was still good but out of warranty, which I removed from a Jeep Grand Cherokee. It is a size 26 battery which has a standby power number of 150, meaning it can supply 25 amps for 150 minutes. I plan to add another opener and this should be more than enough to power both. It also can run the lights that came with the solar panel kit. The Jeep's battery is on a shelf in the

back of the garage and wired to the garage door opener with 14 gauge wire.

Hardware

Figure 1 shows a photo of the prototype that is still in operation. (The circuit is simple enough to build and use on a prototyping board.) **Figure 2** is a printed circuit board (PCB) version that is more professional looking and easier to hook up. **Figure 3** is the schematic, and **Figure 4** shows a wider angle with the sequencer connected to the garage door opener, garage battery, truck, and ATV.

I chose the Parallax BASIC Stamp 1 microcontroller, mainly because I had one from another project and it is easy to use. It also has an onboard regulator, brown-out circuitry, and a reset input pin. The Stamp reads an 0834 Analog-to-Digital Converter (ADC) which is covered in the BASIC Stamp applications manual.

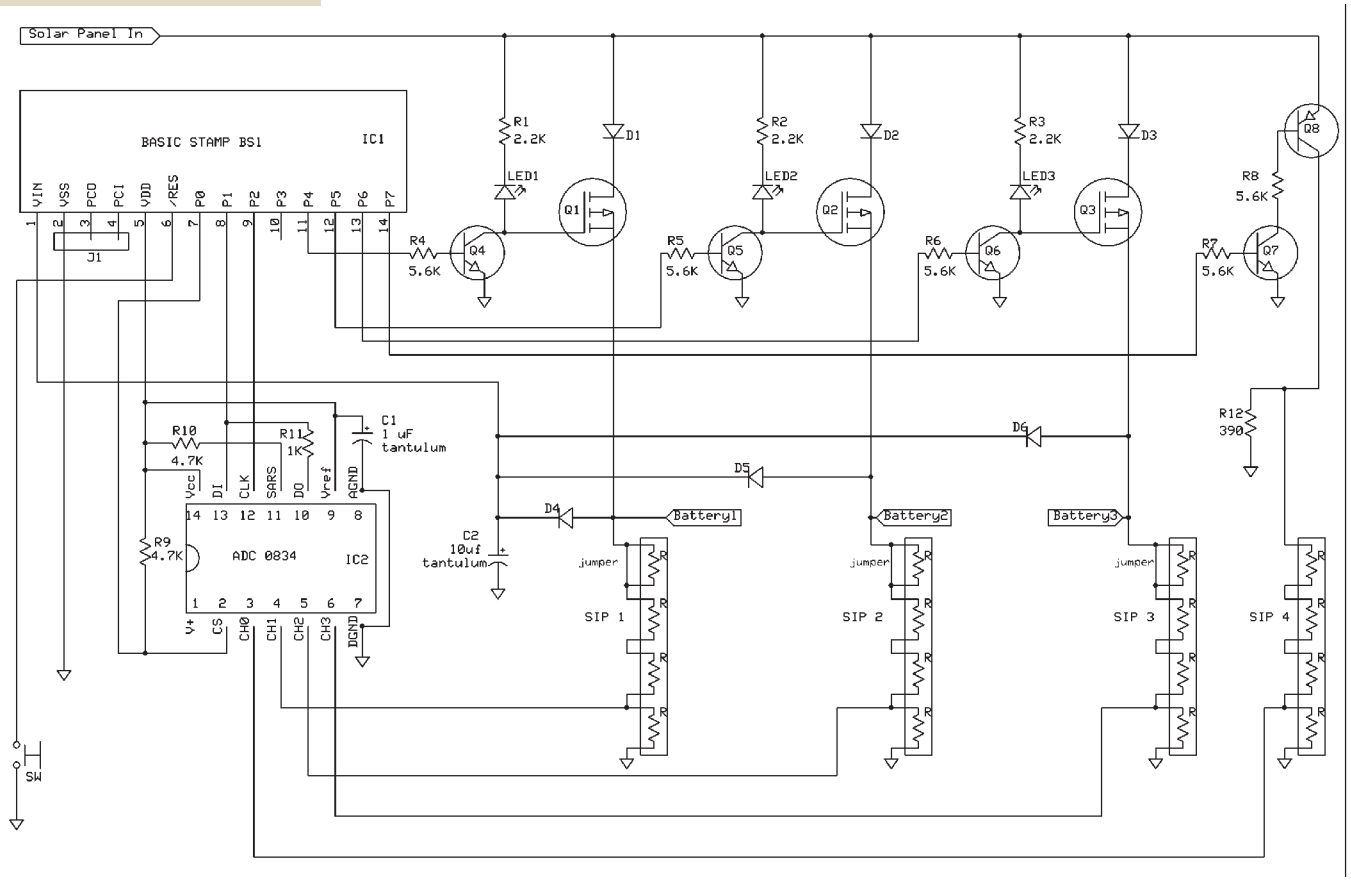
Because the ADC inputs can only measure up to five volts, the battery voltage is divided by three, using a resistor divider with an isolated 10K eight-pin Single In-line Package (SIP) resistor network. Since the resistors in the SIP are made using the same process, their values are all very close to each other. The tolerance is 2%. This can also be done with discrete resistors, but with less accuracy unless the resistors are matched.

This load is on the battery all of the time; the current draw should be as low as possible. I used a 10K SIP — with three of the resistors in series — which uses 0.45 mA (13.5/30K). A higher value SIP resulted in less accurate readings due to the higher input impedance on the ADC input. The open circuit voltage of the solar panels can be as high as 23 volts; the ADC input for them is divided by four. It uses all four resistors in the SIP. During the load test of the solar panels, dividing by four keeps the voltage on the ADC input less than five volts. Power for the Stamp and ADC is supplied by the battery(s) through diodes D4, D5, or D6. That way, it doesn't matter which output is connected to a battery or left open.

Power Circuit

In order to reference the ADC to ground, P-channel MOSFETs (Q1, Q2, and Q3) are used. The MOSFETs need very little current to be turned on, and have a very low on resistance. It is a P-channel IRF 5305 which has a built-in bypass diode. The bypass diode will allow a charged battery to push current to a charging battery when the MOSFETs are off. The purpose of diodes D1, D2, and D3 is to block this current. They are Schottky MBR2535CTs which have a lower voltage drop than standard diodes. The diodes are rated for 30 amps, and the MOSFETs are

FIGURE 3. Schematic.

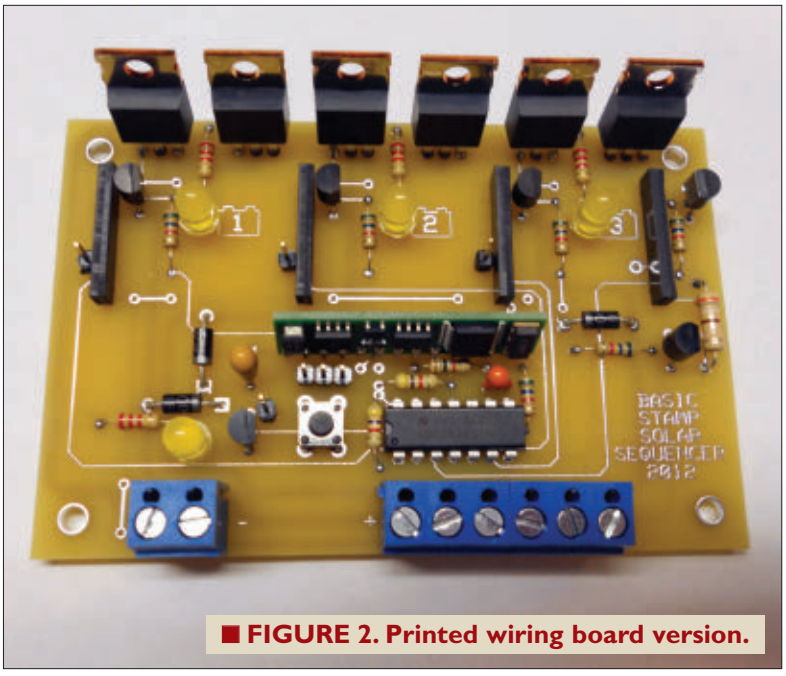


John Guyer can be contacted by email at solarsequencer@verizon.net.

rated for -31 amps. The MBR2535CT has two diodes in a TO-220 package — both of which are used in parallel.

Cheaper components with less current handling capability could be used — especially for a lower capacity panel — but a MOSFET with a low on resistance typically has a high current rating. I originally thought this could be used with a 120 VAC charger capable of 10 amps, but never used it that way other than for testing. The voltage drop across the diode and MOSFET is less than 0.5V, and most of that is across the diode. Since the maximum current is less than two amps, neither device requires a heatsink.

Each particular MOSFET is turned on by the Stamp 1 using a 2N3904 NPN transistor, along with the charging LED. The LED is not very bright because the 2.2K resistor sets the current at about 5 mA, which is a trade-off between being able to see it and current consumption. I also considered using a PNP power transistor and using the base current to light the LED, but the on resistance was high. A relay would work too, but the coil current is wasted and rather high. The MOSFET is ideal for this application.



■ **FIGURE 2. Printed wiring board version.**

Software

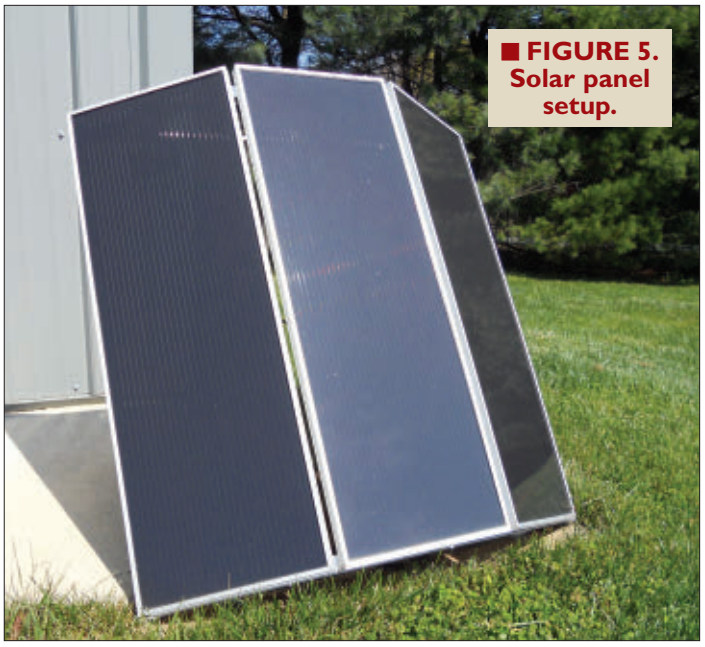
The details of the code (available at the article link) are included in the code comments, but here is a brief summary of how it works. When the program starts, the Charge routine load-tests the solar panel capacity by turning on Q4, which causes about 30 mA to flow through the 390 ohm resistor. This value was chosen only because it is close to the standby current of the garage door opener. If the ADC reading is greater than the startCharge value (13 volts), the Charge1 routine is executed. If not, it calls Night which sleeps 10 minutes and tries again. The Charge1 routine checks the first battery. If it is less than 13 volts but greater than 10 volts, it calls the ChargeLoop subroutine. If not, it checks the next battery. Since the battery voltage drops very slowly, at the end if none of the batteries have been charged, it waits for a minute then executes again. ChargeLoop is called if any of the batteries need to be charged, and it turns on a MOSFET allowing the solar panel to charge the battery. It checks the voltage every five seconds until the voltage is greater than stopCharge (14.2 volts), then turns off the MOSFET and returns to the Charge routine.

The ChargeLoop subroutine also stops charging approximately every 20 minutes, load-tests the solar panel capacity, and (if it is still high enough) resumes charging. If not, it calls the Night routine and sleeps for 10 minutes. The Stamp uses very little power during sleep.

Construction

The prototype circuit was constructed on a

■ **FIGURE 4. Garage installation (note circles which show locations of system components).**



■ **FIGURE 5. Solar panel setup.**

RadioShack prototyping board (as shown in **Figure 1**). It is simple enough to build with point-to-point wiring. I soldered a wire over the circuit trace at the top that carries the solar panel current (because it isn't intended to carry much current). I also covered the entire trace with solder between the MOSFET and the wire leading to the barrier strip. The input from the solar panel and output to the battery(s) is wired to a barrier strip. All of the ground leads are connected together on the barrier strip. From that strip, the truck's battery is connected with the same type of large clamps that an AC charger uses. The ATV and lawn mower use cigarette lighter plugs.

Be extra careful when making these connections, since lead acid batteries can push a lot of current and burn up components — not to mention cause a fire.

The layout of the parts on the board is the same as shown in the **schematic**. There are a few traces that are cut between the Stamp and ADC. Pins P1 and P2 on the Stamp line up with pins 13 and 12 on the ADC; the other traces between those two components were cut. Traces between SIP pins were also cut; refer to the **schematic** and cut where there is no connection between pins. The two terminals on the right of the barrier strip are really not needed, so I used them to connect to a cigarette lighter socket; the orange wire connects it to the garage battery. This socket is used to power a 12V trouble light from the garage battery. There are two pushbutton switches on the left in **Figure 1**. The lower one is connected to the Stamp reset pin; the upper one isn't used and not necessary (it's left over from an earlier design).

The six-pin SIP I used on the prototype isn't available from Jameco anymore; the one on the **Parts List** has four resistors (eight-pin). The **schematic** shows how the first resistor is just shorted out on the battery dividers.

The circuit board and barrier strip are mounted on a piece of 1/4″ plywood. The blister pack that the RadioShack prototyping board comes in can be used as a cover for the circuit board by cutting some slots in the top for the diode and MOSFET tabs to go through.

The printed wiring board is the same basic **schematic** but the layout is different, and the solar panel and batteries are connected to it with a separate terminal strip. Although I made various mistakes on this version, it still works fine. An improved design has the screw terminal blocks mounted directly on the board, with no separate barrier strip to mount and wire. It also has an LED driven by the Stamp pin P3 that is on when there is enough solar panel capacity but none of the batteries are charging. That way, the only time there is no LED lit is when the Stamp is in the sleep state.

PARTS LIST

ITEM	DESCRIPTION	QTY	SOURCE
IC1	BASIC Stamp 1	(1)	Jameco 127693,
IC2	ADC 0834	(1)	Jameco 1252331
Q1, Q2, Q3	IRF 5305	(3)	Jameco 1559965
D1, D2, D3	MBR2535CT	(3)	Jameco 618097
Q4, Q5, Q6, Q7	2N3904 NPN	(4)	Jameco 178597
Q8	2N3906 PNP	(1)	Jameco 178618
D4, D5, D6	1N4001	(3)	Jameco 35975
LED1, LED2, LED3	LEDs (yellow)	(3)	Jameco 34825
C1	1 µF tantulum	(1)	Jameco 94388
C2	10 µF tantalum	(1)	Jameco 94080
SIP1, SIP2, SIP3, SIP4	10K isolated SIP	(4)	Jameco 856909
R1, R2, R3	2.2K 1/4 watt	(4)	
R4, R5, R6, R7, R8	5.6K 1/4 watt	(5)	
R9, R10	4.7K 1/4 watt	(2)	
R11	1K 1/4 watt	(1)	
R12	390 1/2 watt	(1)	
SW	Pushbutton switch	(1)	Jameco 153252
J1	Pin header	(1)	Jameco 103393
Barrier Strip, eight-position			
or			
Connector Terminal Block	Two-position	(1)	Jameco 152347, 5.08 mm
Connector Terminal Block	Three-position	(2)	Jameco 152355, 5.08 mm
16 or 14 gauge red/black DC power wire			
Battery clamps or cigarette lighter plug			

Testing and Operation

The solar panel is connected to the solar input, and a lead acid battery is connected to one of the battery outputs; double-checking the positive and negative connections. Connect wires to the barrier strip first, then connect to the battery. If the battery

The parts list is slightly different for the PCB version. There are terminal blocks on it and an extra 2N3904 transistor, LED, and 5.6K and 2.2K resistors. Those parts are not on the schematic, since they were added onto the PCB only and are not on the prototype board, either. It will still work fine without them. Check the article link for details on how to get the printed circuit board if you're interested.

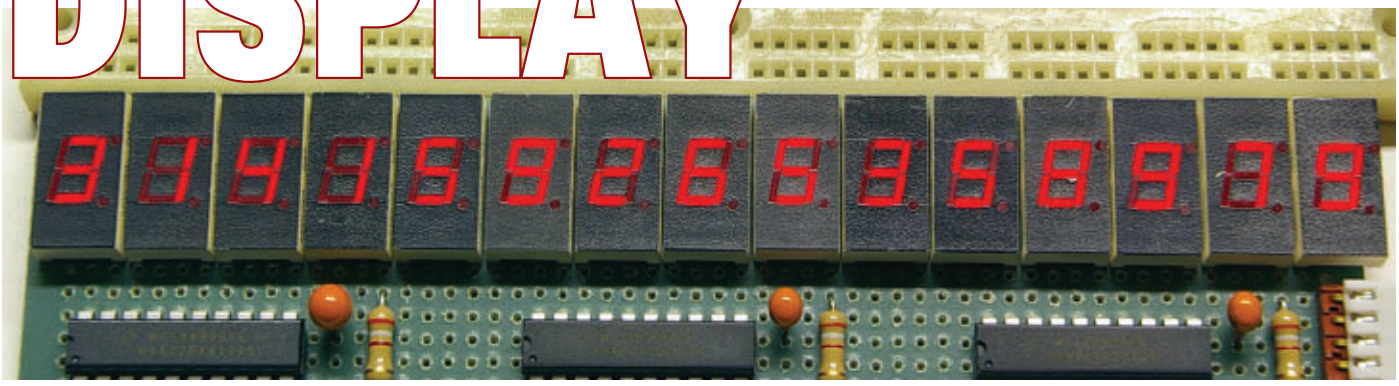
voltage is less than 13V, the LED for that battery output will light. If the LED does not light and the battery voltage is above 13V, connect a load such as an automotive light bulb to the battery. If the battery is in a vehicle, opening the door will load it when the interior lights turn on. This will usually lower the voltage enough that the LED will light. Close the door or remove the load.

Once the battery voltage is above 14.2V, the LED will turn off. This will happen rather quickly if the battery is near full charge on a sunny day. This procedure is repeated for the other battery outputs. For operation, connect the other batteries to the barrier strip first, then the battery, and let the sun do the rest. To get the garage door opener working, connect its battery power leads to a 12 volt lead acid battery (it uses 1/4" female quick connectors) and the battery to the solar sequencer. It won't come on unless it is plugged into AC power. Connect a power inverter to the battery and plug the garage door opener into it, or use a long extension cord (or generator) to plug into AC power. I used a 400 watt inverter, but 100 is probably enough as long as it doesn't have to open the door. The garage door opener's LCD display will show "charging battery."

Unplug it and it will continue to run on the battery. The display will still alternate between time and temperature, and the time can still be set. The only things I don't like are the display always scrolls "battery backup enabled" across the bottom; if the voltage drops below 12.5, it will beep every minute, and there is an orange LED on all of the time. The lights also don't work — they need AC power — but the Harbor Freight solar panel kit comes with two nice 12 volt fluorescent lights that can be wired up separately (just not turned on by the garage door opener). I have been using the prototype version of this design with the garage door opener for a year now, but only for six months with the Jeep's old battery. It was a fun project, and a great way to use solar energy to power the garage. **NV**

Nuts & Volts 8 CD-ROMs & Hat Special!
That's 96 issues.
Complete with supporting code and media files.
NUTS VOLTS 2009 Volume 30, No. 1-12
NUTS VOLTS 2010 Volume 31, No. 1-12
NUTS VOLTS 2011 Volume 32, No. 1-12
NUTS VOLTS 2008 Volume 29, No. 1-12
NUTS VOLTS 2007 Volume 28, No. 1-12
NUTS VOLTS 2006 Volume 27, No. 1-12
Nuts & Volts 2005 Volume 26, No. 1-12
Nuts & Volts 2004 Volume 25, No. 1-12
NUTS AND VOLTS Magazine
Free Shipping!
Only $169.95
www.nutsvolts.com

BUILD THE PI SCROLLING DISPLAY



By Dan Gravatt

I like the look of seven-segment LED displays and came up with a couple of fun applications for them: a scrolling display of the digits of pi (3.14159…) and my own desktop version of the National Debt clock. The five-digit Freescale MC14489 can be daisy-chained to support displays of more than just five digits, so I settled on stringing three of them together for a 15-digit display. This is long enough to give a pleasing appearance when scrolling, and to display all the digits of the national debt (at least for now). This is a versatile system which can be adapted to plenty of other uses, too.

Coding and Math

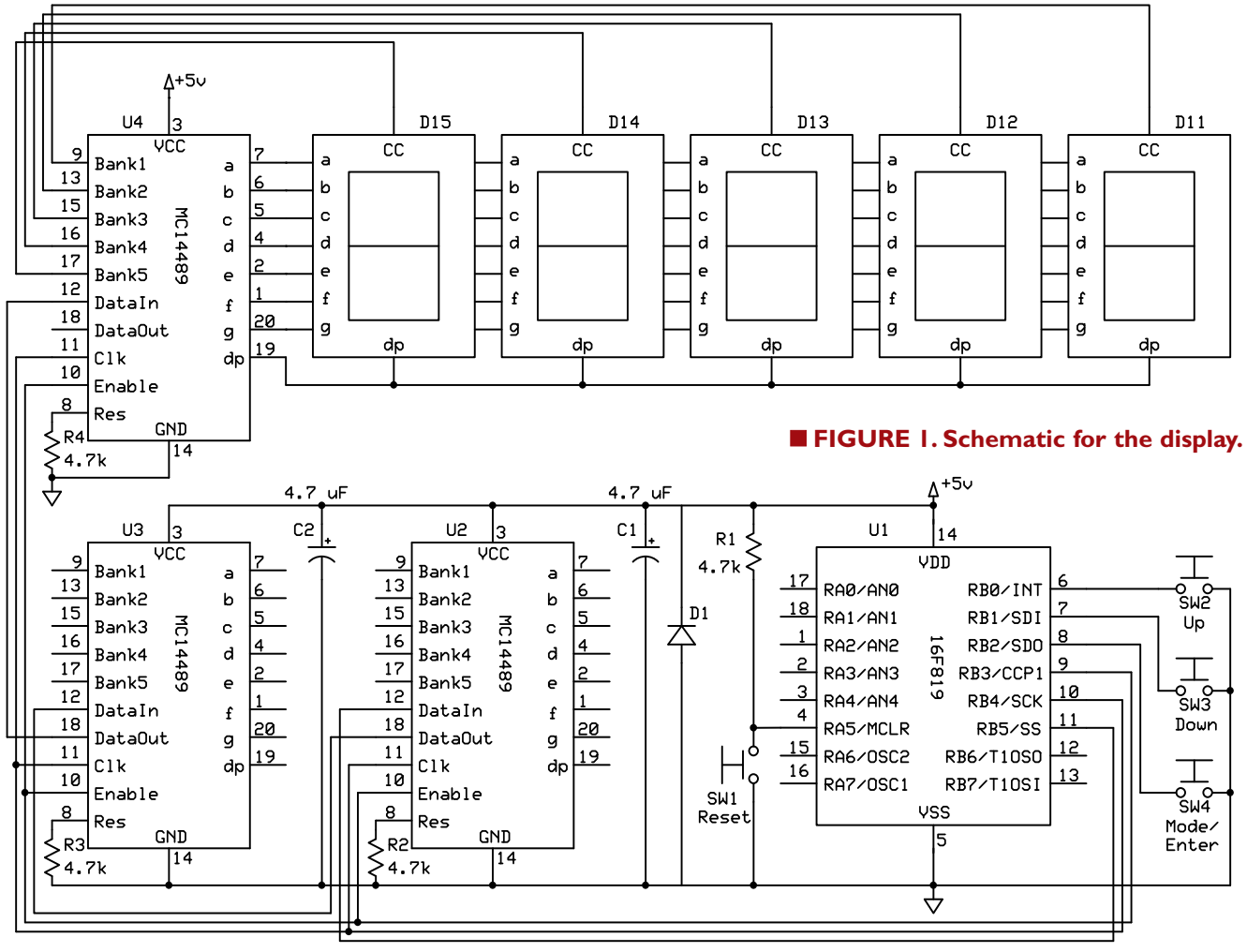
My original plan for the scrolling pi display was to use a PIC microcontroller to actually calculate the digits prior to displaying them. There are some fairly sophisticated formulae called "spigot algorithms" (see **sidebar**) available which can calculate each successive decimal digit without having to calculate the previous digits. It looked like they could be converted into PIC code. I found that my math skills weren't sufficient to get these algorithms to work (even in a spreadsheet), though, so I never got to try to write the PIC code. Instead, I settled for downloading the first 1,100 or so decimal digits of pi and storing them in the PIC which displays them in a loop. The pi data is stored in the PIC's Flash memory during device programming with the POKECODE instruction (take a look at the source code file at the article link). Be careful not to overwrite the program code!

The math for the National Debt clock is very straightforward — all we need to do is look up the current amount of debt and the rate of increase, enter them into the PIC, and then keep a running total with time. This information is available at **www.brillig.com/debt_clock**, among other places. Take a look at the PICBASIC PRO code (listing available at the article link) and the embedded comments to see how a 15-byte array variable is used to hold either the pi digits or the national debt value. Addition of the numbers for the national debt is done on a byte-by-byte basis within the array variable, carrying from one byte to the next as necessary.

Design

The MC14489 display drivers use a synchronous serial interface requiring three wires: data, clock, and enable. I selected a straightforward three-button user interface (up, down, and enter) to set the values for the National Debt clock. Since the display and the user interface are the only external interfaces for the PIC, a low pin count device is all that is needed.

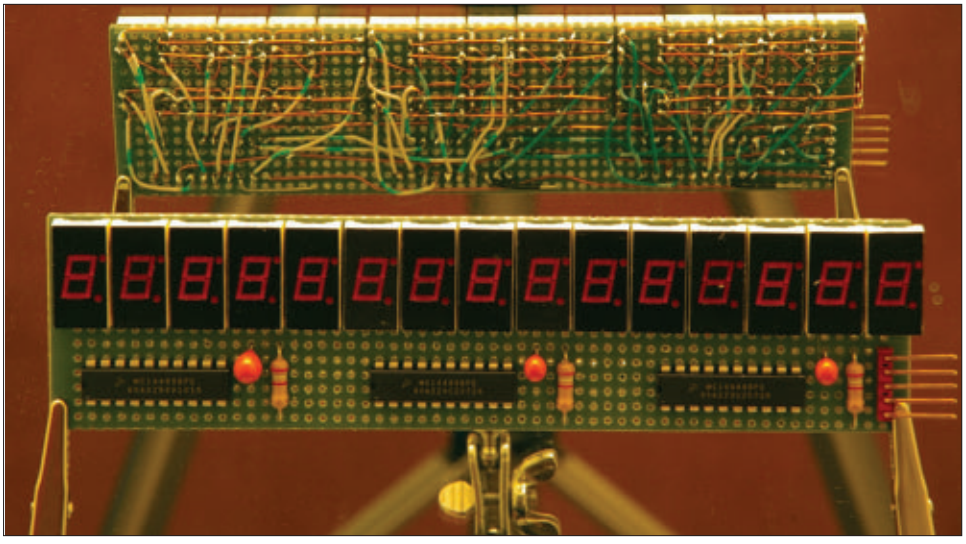
I did want to store as many pre-calculated digits of pi in the PIC as possible, so I looked for a device with a fair amount of memory. The closest device I had on hand was a 16F819: an 18-pin device with 2K words of Flash. Other 18-pin devices with more memory (such as the 16F87 or 16F88) could also be used. The schematic is shown in **Figure 1**. I have omitted the LED displays for digits 1-5 and 6-10 for clarity, since they wire up the same as for digits



■ **FIGURE 1. Schematic for the display.**

11-15. The user interface and MC14489 interface are on port B. This takes advantage of the available weak pull-ups on this port for the input buttons; it also reduces the parts count. The 16F819 has the option of using an internal oscillator and internal MCLR pull-up resistor which can free-up additional pins on port A. In this design, I have MCLR pulled up externally so the PIC can be easily reset. I am using the PIC's internal oscillator to free-up I/O pins RA6 and RA7 for future use, and I set the oscillator frequency to 4 MHz by configuring the OSCCON register in the code. Several other I/O pins on port A and port B are available to add other functions, sensors, etc., to the circuit, or to interface the display module to external systems.

When you program your PIC, you will need to select the "INTIO2" oscillator configuration option to enable the internal oscillator. Note that not all programmer software



■ **FIGURE 2. Front and back of the prototype display; note the rat's nest of point-to-point wiring.**

The National Debt Clock

The official National Debt clock is a billboard-sized running total dot-matrix display which constantly updates to show the current United States gross national debt and each American family's share of the debt. It is currently installed on Sixth Avenue (Avenue of the Americas) in Manhattan, New York City.

The idea for the clock came from New York real estate developer Seymour Durst, who wanted to highlight the rising national debt. In 1989, he sponsored the installation of the first clock which was erected on 42nd Street close to Times Square. At the time, the national debt remained under $3 trillion, but was rising. The clock was temporarily switched off from 2000 to 2002 due to the debt actually falling during that period.

In 2004, the original clock was dismantled and replaced by the current clock at the new location one block away. In 2008, the US national debt exceeded $10 trillion for the first time, leading to press reports that the clock had run out of digits.

The original clock outlived Seymour, who died in 1995, with Seymour's son Douglas taking over the responsibility for the clock through the Durst Organization. As of September 2009, Douglas Durst's cousin Jonathan "Jody" Durst — with whom he shares a co-presidency of the company — is in the process of taking over the day-to-day operations as president. In an interview with *The New York Times*, Jonathan Durst has said that maintenance of the clock is planned "for years to come."

Douglas Durst has been quoted as saying that the clock represents a non-partisan effort; he has further explained the motivation behind the project in terms of intergenerational equity: "We're a family business. We think generationally, and we don't want to see the next generation crippled by this burden."

According to Douglas, his father had been toying with the basic idea of drawing attention to the growing national debt since at least 1980, when during the holiday season he sent cards that said "Happy New Year. Your share of the national debt is $35,000" to senators and congressmen. In the early eighties (when Durst first developed the idea of a constantly updated clock), the technology required to implement the project was not yet available.

First Clock

With the national debt at 2.7 trillion, the original 11 by 26 foot (3.4 × 7.9 m) clock was constructed at a cost of $100,000. It was mounted a block from Times Square on a Durst building at Sixth Avenue near 42nd Street; it faced the north side of 42nd Street and Bryant Park across the intersection. Built by the New York sign company Artkraft Strauss, the clock featured a dot-matrix display with the then-typical character resolution of 5x7. Similar to the second clock, the updating mechanism was such that the display was set to the estimated speed of debt growth (odometer-style) and adjusted weekly according to the latest numbers published by the US Treasury. Up until the week before his death, Seymour himself adjusted the tally via modem. Since his passing, Artkraft Strauss has been keeping the figures current.

In 2000 — due to an improving debt situation — the clock started to run backwards. With the original purpose of the clock being to highlight the rising debt and the reverse giving a mixed message (and with the display not being designed to properly run backwards), the clock was unplugged and covered with a red, white, and blue curtain in September 2000, with the national debt standing at roughly $5.7 trillion. The clock was not dismantled, however, and in July 2002 the curtain was raised and the clock once again picked up tracking a rising debt, starting at $6.1 trillion.

Second Clock

In 2004, the original clock was moved from its location near 42nd Street; the building has since made way for One Bryant Park. An updated model — which can run backwards — was installed one block away on a Durst building at 1133 Avenue of the Americas (Sixth Avenue). It is mounted on the side wall of the building which faces West 44th Street. The new clock is outfitted with a dot-matrix display of higher resolution than its predecessor which emulates the customary seven-segment numeral patterns, allowing the numbers to be read more easily.

In the midst of extensive media attention during the financial crisis beginning in 2007, some news reports mentioned the National Debt Clock, highlighting the fact that its display had run out of digits when the US gross federal debt rose above $10 trillion on September 30, 2008.

An overhaul or complete replacement adding two more digits to the clock's display is being planned.

Similar Projects

The German National Debt clock is located at the Berlin headquarters of the taxpayer watchdog group, Bund der Steuerzahler.

The idea of conveying a message through a periodically updated clock found an earlier expression in the Doomsday clock. However, the innovation of the National Debt clock was to feature a constantly running counter; it has since inspired similar projects elsewhere, both in the US and further afield. Various tracking counters of national debt are also kept online.

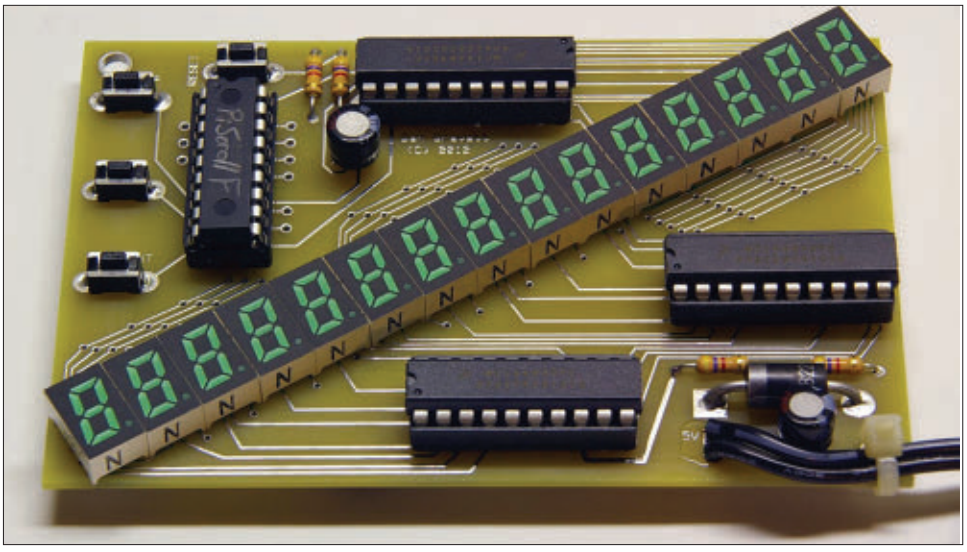
The National Debt clock has been credited as the inspiration behind other running totalizers, for example, an AMD campaign employing an electronic billboard; instead of a debt, it tracked the supposed additional cost of using a rival chip.

For more details on this, visit **Wikipedia.org**.

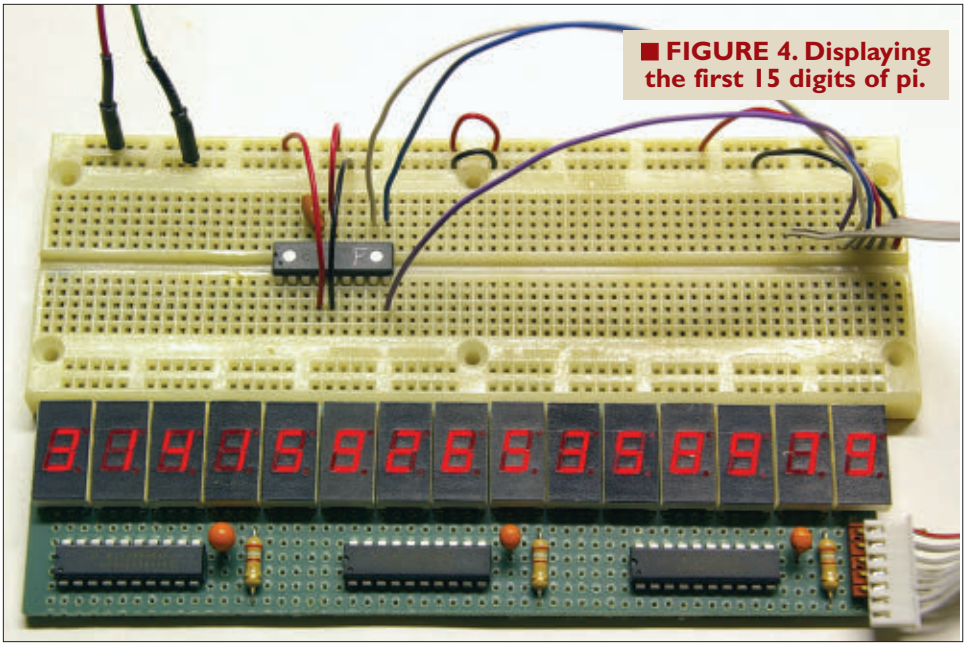
SPIGOT ALGORITHMS

A **spigot algorithm** is a type of algorithm used to compute the value of a mathematical constant such as π or e. Spigot algorithms are unique because they do not require the total number of digits to be fixed beforehand, and do not require the computation of several intermediate results which are combined to produce the final result. There are two kinds of spigot algorithms: (1) those that can produce a single, arbitrary digit (also called **digit extraction algorithm**); and (2) those that produce a sequence of digits, one after the other. The Bailey-Borwein-Plouffe formula is a digit extraction algorithm for π which produces hexadecimal digits.

A sequential spigot algorithm for π was produced by Stanley Rabinowitz and Stanley Wagon (this algorithm is sometimes referred to as "*the* spigot algorithm for π"). Spigot algorithms that produce a sequence of digits begin producing digits and produce them continuously, rather than waiting for the entire algorithm to finish. Spigot algorithms are known for π and e. Spigot algorithms typically work in a particular radix, such as hexadecimal or binary number. [From Wikipedia.]



■ **FIGURE 3. Layout of the PCB with a diagonal arrangement of the LED displays.**



■ **FIGURE 4. Displaying the first 15 digits of pi.**

Dan Gravatt can be reached at dgravatt@juno.com.

uses Microchip's standard name for this option; my software calls it "IntRC."

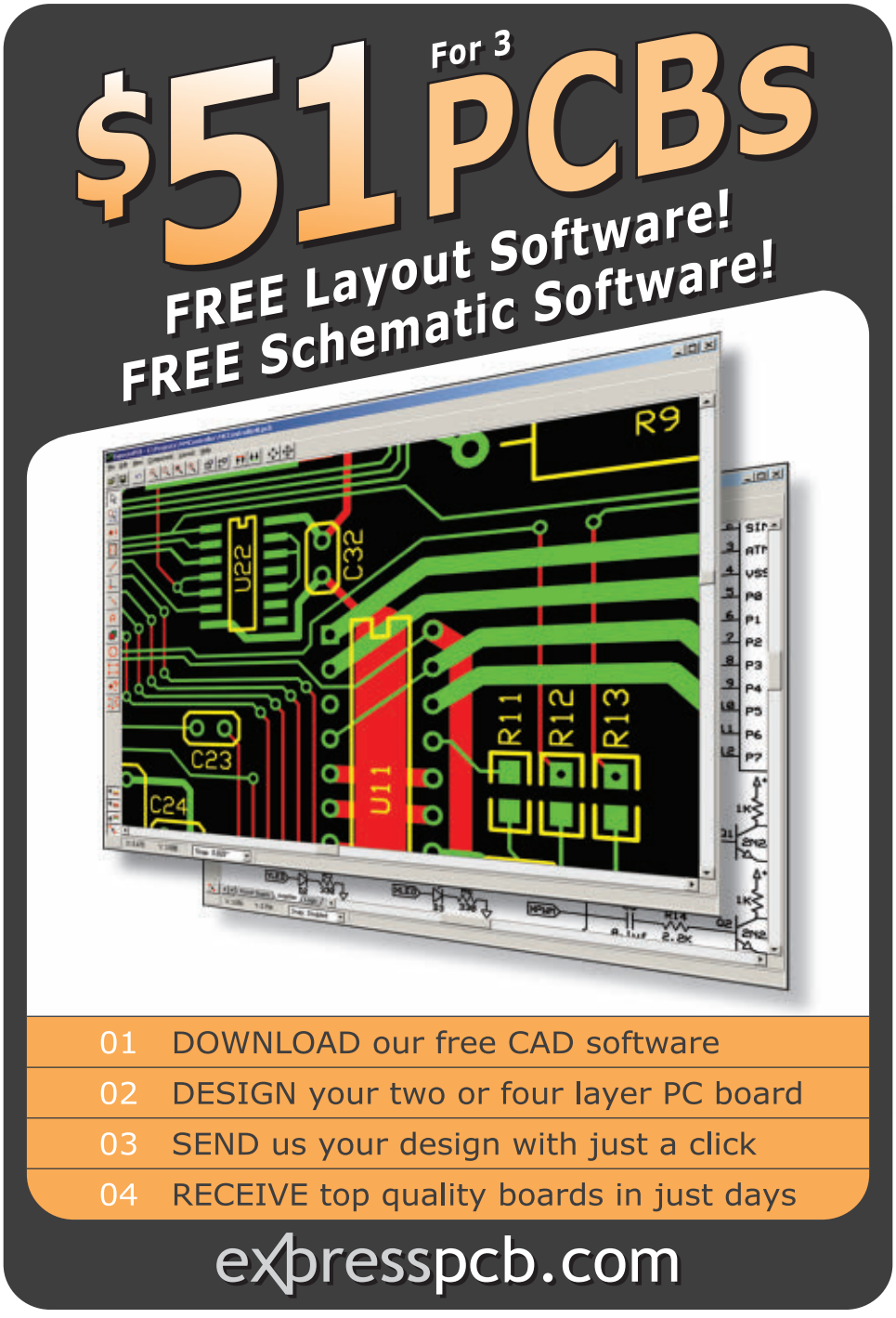
The Build

The MC14489 makes it very easy to interface a microcontroller with common-cathode LED displays, but there is still a lot of wiring needed to multiplex those displays and connect them to the drivers (**Figure 2**). This is clearly a project that needs a custom printed circuit board (PCB) to be practical. I like ExpressPCB's mini-board service because it's very reasonably priced, but the fixed board size (3.8" by 2.5") seemed too small to hold 15 LED displays plus the PIC and driver chips. After scouring parts suppliers to find small displays and dusting off my trigonometry skills to align them diagonally across the board, I came up with the board layout in **Figure 3**. ExpressPCB doesn't allow components to be placed at odd angles like this, so I had to create a custom pad array from scratch to fool the software into aligning the displays at the proper angle of about 31°. The displays I selected are made by Rohm; they come in several colors, and each LED display is only 7 mm wide with a character height of 8 mm or 0.31 inches. It's a tight fit with a lot of curving

PARTS LIST

ITEM	DIGI-KEY PART#
PIC 16F819 microcontroller, 18-DIP	PIC16F819-I/P-ND
(3) MC14489 five-digit LED display driver, 20-DIP	MC14489BPE-ND
(15) Seven-segment common-cathode LED display	Rohm LA-301xL series (*"x" denotes color*)
(4) Pushbutton momentary switch	450-1665-ND
(4) 4.7K ohm 1/4 watt resistor	4.7KQBK-ND
(2) 4.7 µF tantalum capacitor	399-3559-ND
1N5401 diode	1N5401-TPCT-ND

(For info on programmed PICs and circuit boards, check for details at the article link.)



traces around the displays but it works, and the diagonal line of displays complements the look.

I recommend using sockets for the four ICs to reduce the risk of damaging them during soldering. However, if you plan to mount the board behind a panel or in an enclosure, note that the height of the chips in their sockets exceeds the height of the displays themselves. The bypass capacitors can also be mounted horizontally to keep them below the plane of the displays. I have included extra pads on the unused I/O pins on the PIC so you can "roll your own" ICSP interface if you choose to solder the chips to the board (though you will have to add a diode between the MCLR pin and its pull-up resistor to protect the rest of the circuit from the programming voltage).

Scroll That Beautiful Pi Footage

The display defaults to scrolling the digits of pi on power-up (**Figure 4**). After scrolling all the digits, the display will pause and then restart from the beginning. If you press and hold the mode/enter button while powering up or resetting the PIC, the display enters National Debt clock mode.

First, you will enter the current value of the debt, starting with the most significant digit and using leading zeros as necessary. Select each digit with the up and down buttons, then press enter to adjust the next digit. Then, enter the rate of increase of the debt — in dollars per second — in the same manner.

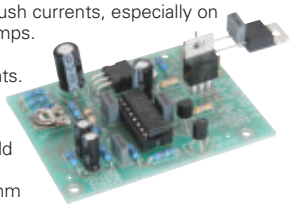
Now, you can watch our debt pile up in near real time, or have a more relaxed experience watching pi scroll by. **NV**

Projects for the Electronics Enthusiast

AUTOMOTIVE KITS

10A 12VDC Motor Speed Controller
KC-5225 $18.00 plus postage & packing

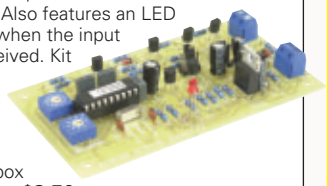
Ideal for controlling 12V DC motors in cars such as fuel injection pumps, water/air intercoolers and water injection systems. You can also use it for headlight dimming and for running 12V DC motors in 24V vehicles. The circuit incorporates a soft start feature to reduce inrush currents, especially on 12V incandescent lamps. Includes PCB and all electronic components.



- Kit includes PCB plus all electronic components to build the 10A version.
- PCB size: 69 x 51mm

Speedo Corrector MkII
KC-5435 $39.75 plus postage & packing

When you modify your gearbox, different ratio or change to a large circumference tyre, it may result in an inaccurate speedometer. This kit alters the speedometer signal up or down from 0% to 99% of the original signal. Also features an LED indicator to show when the input signal is being received. Kit supplied with PCB with overlay and all electronic components.



- Recommended box UB5 (use **HB-6013 $2.50**)
- PCB size: 105 x 61mm

KIT OF THE MONTH

Ultrasonic Antifouling for Boats
KC-5498 $179.50 plus postage & packing

Marine growth electronic antifouling systems can cost thousands. This project uses the same ultrasonic waveforms and virtually identical ultrasonic transducers mounted in a sturdy polyurethane housings. By building it yourself (which includes some potting) you save a fortune! Standard unit consists of control electronic kit and case, ultrasonic transducer, potting and gluing components and housings. The single transducer design of this kit is suitable for boats up to 10m (32ft); boats longer than about 14m will need two transducers and drivers. Basically all parts supplied in the project kit including wiring. (Price includes epoxies).

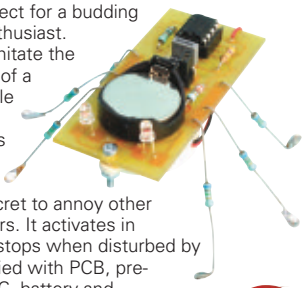
- 12VDC
- Suitable for power or sail
- Could be powered by a solar panel/wind generator
- PCB size: 78 x 104mm

Best Seller!

Now available Pre-built:
Dual output, suitable for vessels upto 14m (45ft)
YS-5600 $562.00
Quad output, suitable for vessels upto 20m (65ft)
YS-5602 $749.50

Crazy Cricket and Freaky Frog Kit
KC-5510 $14.50 plus postage & packing

A fun first project for a budding electronics enthusiast. Designed to imitate the chirping noise of a cricket or gentle croaking of a frog (alternates at power up), while keeping its location secret to annoy other family members. It activates in darkness and stops when disturbed by light. Kit supplied with PCB, pre-programmed IC, battery and electronic components.

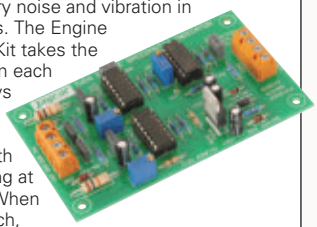


- PCB size: 30 x 65mm

NEW 2012

Marine Engine Speed Equaliser Kit
KC-5488 $25.00 plus postage & packing

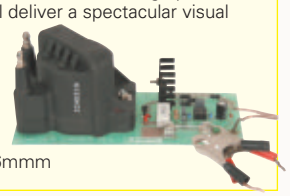
Avoid unnecessary noise and vibration in twin-engine boats. The Engine Speed Equaliser Kit takes the tacho signals from each motor and displays the output on a meter that is centred when both motors are running at the same RPM. When there's a mismatch, the meter shows which motor is running faster and by how much. Simply adjust the throttles to suit. Short form kit only, requires moving coil panel meter (**QP-5010 $11.25**).



- 12VDC
- Kit supplied with PCB, and all electronic components
- PCB size: 105 x 63mm

Jacob's Ladder High Voltage Display Kit MK2
KC-5445 $31.00 plus postage & packing

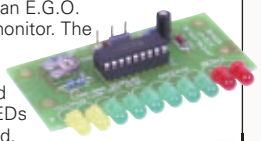
With this kit and the purchase of a 12V ignition coil (available from auto stores and parts recyclers), create an awesome rising ladder of noisy sparks that emits the distinct smell of ozone. This improved circuit is suited to modern high power ignition coils and will deliver a spectacular visual display. Kit includes PCB, pre-cut wire/ladder and all electronic components.



- PCB size: 170 x 76mmm

Mixture Display Kit For Fuel Injected Cars
KC-5195 $12.25 plus postage & packing

This very simple kit will allow you to monitor the fuel mixtures being run by your car. This type of sensor is also known as an E.G.O. (exhaust, gas, oxygen) monitor. The circuit connects to the EGO sensor mounted in the exhaust manifold and the cars battery. PCB, LEDs and components supplied.

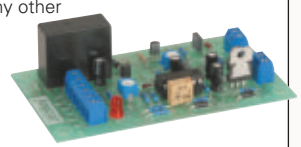


- PCB size: 74 x 36mm

Thousands Sold!

Frequency Switch
KC-5378 $27.50 plus postage & packing

The switch frequency can be set to trip when it is rising or falling, and it features adjustable hysteresis (the difference between trigger on/off frequency). You could configure it to trigger water spray cooling on deceleration, shift light activation, adjustable aerodynamics based on speed, intake manifold switching and much more. It uses a standard tacho, road speed, or many other pulse outputs to switch a relay. Kit supplied with PCB, and all electronic components.



- PCB size: 105 x 60mm

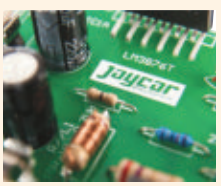
Car Battery Monitor
KA-1683 $13.00 plus postage & packing

Don't get caught with a flat battery! This simple electronic voltmeter lets you monitor the condition of your car's battery so you can act before getting stranded. 10 rectangular LEDs tell you your battery's condition.

- Kit includes PC board and all components
- PCB size: 62 x 39mm

KIT BACK CATALOGUE

If you can't find the kit you are looking for, try the Jaycar Kit Back Catalogue. Our central warehouse keeps a quantity of older and slow moving kits that can no longer be held in stores. A list of kits can be found on our website. Just search for "kit back catalogue".



Attention: Kit Builders

NOW SHIPPING VIA DHL
• FAST DELIVERY • TRACK SHIPMENT

5-10 working day delivery

Post & Packing Charges

Order Value	Cost
$25 - $49.99	$7.50
$50 - $99.99	$20
$100 - $199.99	$40
$200 - $499.99	$60
$500+	$75

- Max weight 12lb (5kg).
- Heavier parcels POA.
- Minimum order $25.

Note: Products are dispatched from Australia, so local customs duty & taxes may apply.

HOW TO ORDER

WEB: www.jaycar.com
PHONE: 1-800-784-0263*
FAX: +61 2 8832 3118*
EMAIL: techstore@jaycar.com
POST: P.O. Box 107, Rydalmere NSW 2116 Australia

*Australian Eastern Standard Time (Monday - Friday 09.00 to 17.30 GMT + 10 hours)

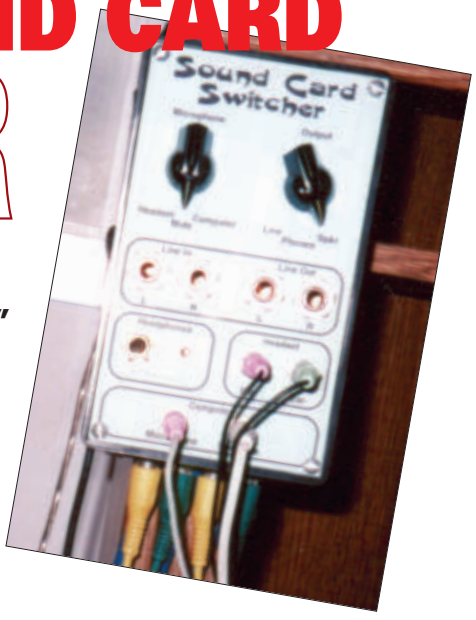
• ALL PRICING IN US DOLLARS

Prices valid until 31/7/2012

Order online: www.jaycar.com

Jaycar Electronics

STREAMLINE YOUR HOME STUDIO WITH A SOUND CARD SWITCHER



BY THOMAS HENRY

Way back, in a previous "Developing Perspectives," editor Bryan Bergeron sketched out some of the logistics of setting up a legitimate home recording studio. This article focuses on one of the more important parts of any setup: the computer sound card.

This device is at the heart of all the analog-to-digital and digital-to-analog activity in the typical home studio. For example, the sound card interacts with the following equipment in my arrangement:

- Computer loudspeakers
- Large over-the-ears headphones
- Small foam-type headphones
- PC mounted microphone
- Headset with earpiece and microphone
- Cassette deck
- Guitar amplifier
- Musical instruments (guitar, synthesizer, drum box, etc.)
- MIDI gear

The trouble is, the typical sound card does so much that it's often a hassle to dig around behind the computer to unplug the patch cords and hook up different ones for a new task. After tolerating this awkwardness for way too many years, I finally decided to do something about it and came up with the sound card switcher. Now, with the flip of a switch (and no rummaging around on my hands and knees behind the computer case) I can rapidly reconfigure things for any number of different audio operations. Sure, it's a simple idea, but you simply wouldn't believe how quickly I can get down to making music now instead of fighting patch cords. If this sounds like something that would improve your efficiency, then read on.

Connect it Once and Leave it Connected

The general idea is to come up with a rig that will accommodate all of your gear. Any patch cords are left connected, and then it's the switches on the front panel that steer the signals to various points. For example, I enjoy burning old tapes to CD, so I leave a cassette deck permanently connected. Sometimes I like to record my electric guitar or homebrew synthesizer; again, I leave both in place. Often, I'll use the computer speakers for playback, but at other times I might prefer headphones. I might even employ a joint headset (microphone and earpiece) for vocal narration. In each of these cases, however, all I have to do is flip a switch to arrive at the patch I want. I'll show you the way I set up my sound card switcher, but obviously, you can readily customize it to match your own requirements.

Incidentally, this makes an excellent weekend project for newcomers to electronics. There's nothing particularly hazardous or difficult about its construction. Since it uses point-to-point wiring throughout and not a printed circuit board, it offers a chance to practice good soldering techniques with very little up-front investment. Last but not least, the beginner will also learn something about the logic of circuit tracing as he or she chases down the signals from one jack to the next. All in all, the sound card switcher is an excellent learning exercise besides being eminently useful.

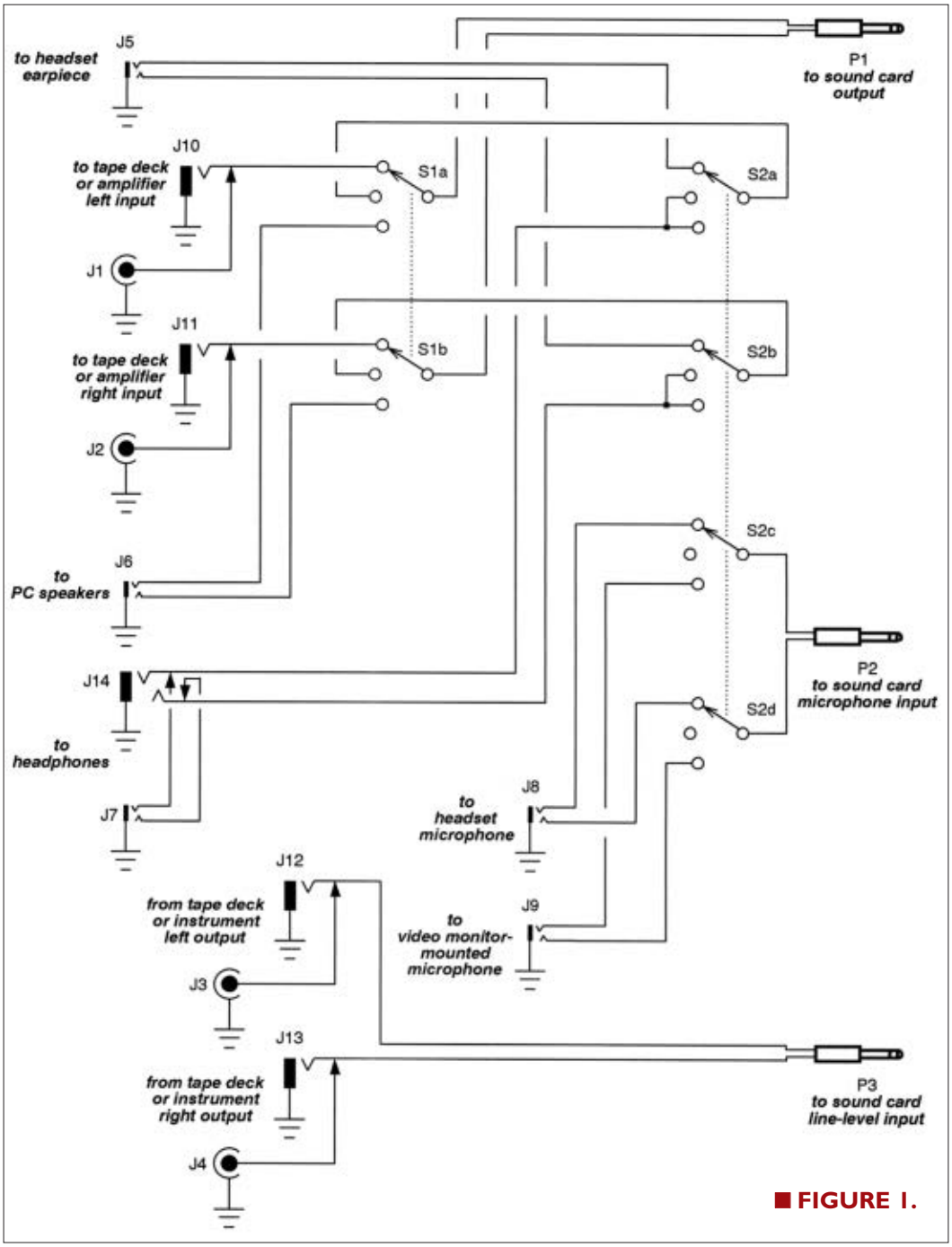
How it Works

Refer to **Figure 1** which shows the schematic. To avoid getting lost in the spaghetti wiring, keep the overall idea in mind. In particular, there are two main controls: the output switch (S1); and the microphone switch (S2).

Obviously, the latter chooses among the various

microphones in the system, while the former routes the output signal to whatever speakers, headphones, amplifiers, etc., you may have. If you've got the big picture in mind, then the details shouldn't be too troublesome.

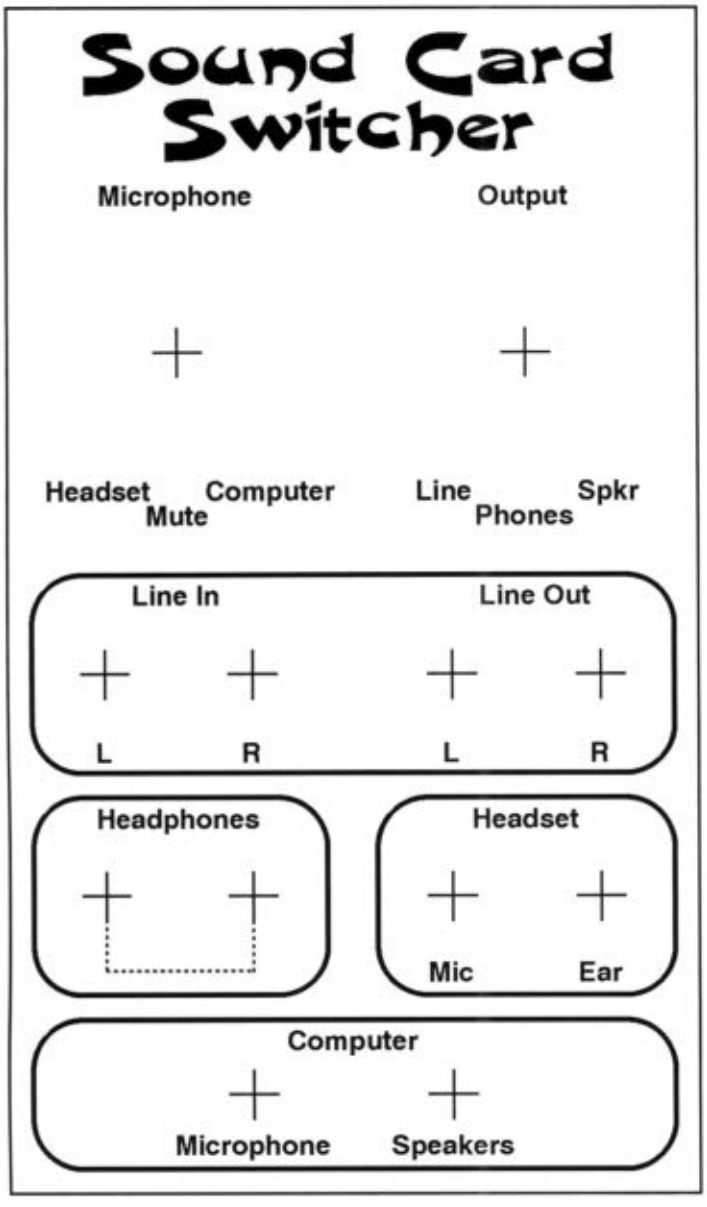
Let's handle the line-level inputs to the computer's sound card first. (Most sound cards have a line-level input, as well as a separate low level microphone input). J3 and J4 are RCA jacks which is the type commonly used on cassette decks. So, the left and right outputs of the deck connect to these guys. Notice that J12 and J13 are normally-closed switching jacks; these are 1/4 inch phone jacks — the size most often needed by musical instruments. If nothing is plugged into them (which is the norm in my studio), then the cassette deck signals make it through unimpeded. If you plug a guitar or music synthesizer into either J12 or J13, then the cassette connection is broken automatically and replaced with an instrument. In this neat way, we can cut down on the number of switches required. By the way, plug P3 is permanently connected to your sound card line-level input. The size is 3.5 mm which is also referred to as a mini-phone plug.



■ FIGURE 1.

What about the microphones? I have a neat little one permanently connected to the front of the PC video monitor at mouth level, but sometimes I also use the one which is part of a headset. The sound card switcher can accommodate both. The headset mic connects to jack J8, while the monitor-mounted one goes to J9. Both of these are mini-phone jacks, but note they are two conductor types (ring and tip, with ground assumed) since microphones for PCs are generally powered affairs. One conductor provides DC to the microphone, while the other passes the audio.

Let's pause for a moment to look over S2 — the microphone switch mentioned earlier. This consists of four electrically independent sections which are mechanically switched simultaneously as the knob is turned. In brief, S2 is a 4P3T rotary switch which is a pretty standard item even if it does sound weird. Now, J8 and J9 thread their way to switch sections S2c and S2d, respectively. Observe that the center terminal of both are left unconnected. This allows you to rapidly mute the microphones with a twist of the wrist should acoustic feedback get the better of you. The upshot is, then, that you can select one microphone, the other, or none at all if silence is what



■ **FIGURE 2.**

PARTS LIST

ITEM	DESCRIPTION
Plugs	
P1 - P3	Stereo 3.5 mm mini-phone plug
Jacks	
J1 - J4	RCA jack
J5 - J9	Stereo 3.5 mm mini-phone jack
J10 - J13	1/4 inch, mono N.C. phone jack
J14	1/4 inch, stereo N.C. phone jack
Switches	
S1	DP3T rotary switch
S2	4P3T rotary switch

(S1 can also be a 4P3T switch; just ignore two of the sections).

Miscellaneous

Shielded cable, solder, knobs, project case, etc.

you're after. Finally, the wipers of S2c and S2d lead to mini-phone plug P2 which is permanently connected to the microphone input of the computer's sound card.

We'll get back to the other two sections of S2 in a moment, but let's see how the loudspeakers are handled next. Jack J6 (a stereo mini-phone affair) is where these connect. If you trace the wiring, you'll see that these (left and right channels) work their way to the bottom lugs of S1a and S1b. Obviously, S1 is a DP3T switch and is the unit called output referred to previously. To make inventory control manageable, you can simply use a duplicate of S2 by just ignoring two of the sections.

Okay, supposing the wiper of S1 is in the lower position, then the speaker lines are routed directly to mini-phone plug P1 which is permanently attached to the speaker output of the computer's sound card. We therefore have normal loudspeaker operation accounted for. Remember, though, there are a couple of options for headphones, as well. Let's tackle them next.

Most fancier over-the-ears headphones terminate through a larger 1/4 inch stereo phone plug, while smaller foam types or ear buds sport a 3.5 mm connector. The sound card switcher can handle both. J14 is the larger of the two, while J7 is the mini unit. Both are stereo, obviously, but notice that J14 is a normally-closed switching jack. Thus, anytime you plug in the big set it will override the smaller phones automatically. Again, this cuts down on the number of switches needed. Obviously, you'll only want one set of headphones operable at any given moment.

So, J14 or J7 wind their ways to S2a and S2b. You'll note that in either the middle or bottom position of these switch sections, the headphones are permitted to pass on to S1. The middle position of S1, in turn, shoots the signal to plug P1 as we saw earlier. In a nutshell, S1 chooses between the loudspeakers or the headphones.

Sometimes a person likes to use a headset (microphone and earpiece all in one). We've already seen how the microphone connection of this was handled via J8, S2c, and S2d. Now, notice that mini-phone jack J5 accepts the earpiece connection in the headset. This goes directly to switch sections S2a and S2b, and the signals can be routed to plug P1 in much the same way as the external headphones were through S1.

Finally, there will be occasions when you don't want the sound card output to go to the loudspeakers or the headphones but rather to a tape deck, stereo system, guitar amplifier, etc. You'll observe that this is possible through the top position of switch S1. In particular, the output from the computer feeds plug P1 which then goes to the wipers of S1a and S1b. These, then, are passed to 1/4 inch phone jacks J10 and J11.

You could patch these to a guitar amplifier, for instance, since that's the normal size connector employed. Or, if you want to send the output to a cassette deck, say, then use RCA jacks J1 and J2. Notice that J10 and J11

implement the usual switching/override business.

So, What's Possible With It?

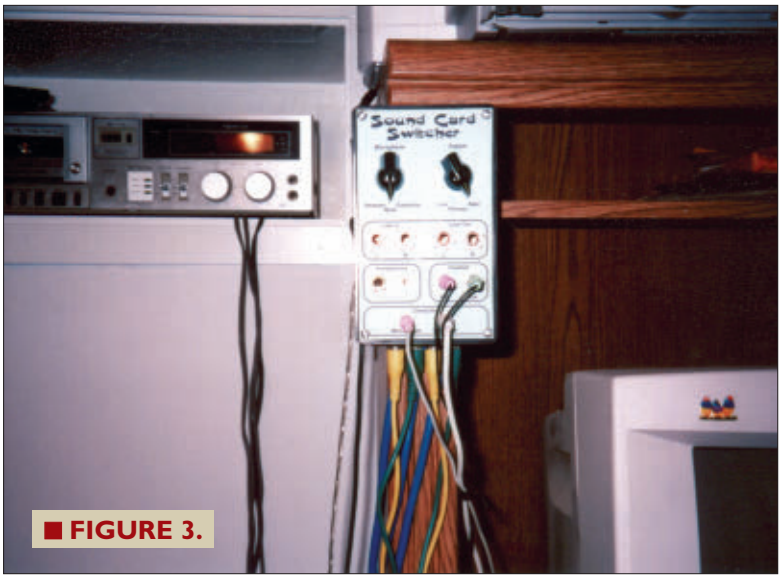
The convoluted wiring of **Figure 1** may have left you scratching your head a bit. Just to make sure you understand what all is possible as you customize things for your own setup, let me tell you how I flip the switches in my rig. Recall that S1 is the output switch, while S2 is the microphone switch. You might want to peek ahead to **Figure 2** which shows what the front panel looks like. On that, you can see the switch labels for each of the three positions which are:

S1 — Output:

- *Line:* The sound card output is routed to either J1/J2 (cassette deck) or J10/J11 (guitar amplifier).
- *Phones:* The sound card output is routed to headphones; S2 determines if these are headphones connected to J7 or J14, or the earpiece in a headset connected to J5.
- *Spkr:* The sound card output is routed to the PC loudspeakers.

S2 — Microphone:

- *Headset:* The microphone in the headset is used at J8, and the sound card output is routed to the earpiece in the headset at J5.
- *Mute:* No microphone is connected, but any headphones or speakers selected continue to work as usual.
- *Computer:* The monitor-mounted microphone is selected at J9, and the headphones at either J7 or J14 are used (not the headset).



■ FIGURE 3.

Warm Up the Iron

Of course, your arrangement may turn out differently from mine depending on the gear you expect to hook up. To let you in on the possibilities, here's how I built my sound card switcher.

You'll want to start by gathering all of the components. The **Parts List** shows the items I used, but your shopping list will probably be a little different to cover your requirements. In any event, none of the parts are particularly hard to come by. For example, Jameco and All Electronics (both advertisers in this magazine) have a very wide selection of switches, plugs, and jacks sure to match what you need for your rendition.

By the way, I was able to find everything I required in my electronics junk box and so didn't have to spend a cent.

I housed the entire thing in a plastic project box rescued from the trash, believe it or not. The front cover is aluminum and secured in place with four small machine bolts. The dimensions weigh in at 6 x 3-1/2 x 2 inches. This appears to be a standard size (at least the cover plate is), so you could probably employ the front panel design shown in **Figure 2** without change. What I did was print the pattern out on a light blue card stock, laminate it with clear sticky-back film, and glue the entire label to the aluminum panel with rubber cement. You could follow suit, if desired, simply by photocopying **Figure 2** on some card stock of your own choosing. By the way, the **figure** also serves as the drilling guide; the crosshairs show where to aim the drill bits.

Figure 3 is a photograph of my rig mounted right on the computer desk within easy reaching distance. As you can see, both switches and most of the jacks appear on the front panel. However, the four RCA jacks (which go to the cassette deck in my situation) are mounted on the bottom of the case. The three sound card cables also exit the box at the bottom.

As for the wiring, as mentioned previously everything was done point-to-point inside the enclosure. Since this was mostly plastic, you might be concerned about 60 cycle hum. It wasn't a problem since I used shielded cabling throughout and also kept the connections short.

Keep in mind that most sound cards also come with a MIDI port. This needs a few additional components to make it match the true MIDI electrical standard, but it could easily be combined with the sound card switcher to unlock every aspect of the card. (I gave the details in "A Do-It-Yourself Sound Blaster 16 Interface," in the April 1997 issue of *Nuts & Volts,* pp. 41-43.)

The sound card switcher has revolutionized the way I work at the computer. Instead of putzing with cables, I can literally start recording or playing back any audio project within one second. So, while this passive gadget will hardly win awards for intricacy, it surely deserves points for usefulness. Anyway, that's my story and I'm sticking with it! **NV**

UPGRADE YOUR 16-BIT MICRO EXPERIMENTER TO 32-BIT FOR16x2 PROCESSING Power!

BY THOMAS KIBALO

Discuss this article in the Nuts & Volts forums at http://forum.nutsvolts.com.

The 16-bit Experimenter was introduced in the December '09 issue of Nuts & Volts. This Experimenter targeted Microchip's 16-bit microcontrollers and is equipped with a +3.3V regulated power supply, a 16x3 LCD display, four pushbuttons, a 32K EEPROM, 10-pin I/O expansion bus, a 32 kHz clock crystal, and the Microchip ICSP interface for programming and debugging. The Experimenter form factor was made for easy insertion into solderless breadboard environments. Now, what if we told you that you can now use a 32-bit processor with this same Experimenter? Take a look at ***Figure 1****.*

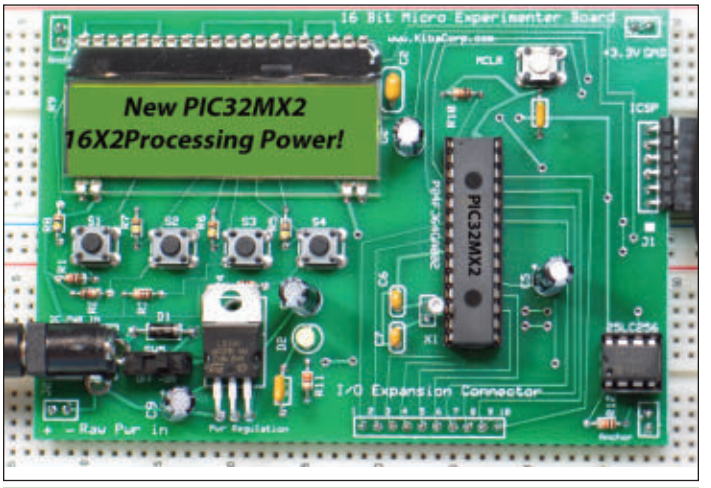


FIGURE 1. The 16-bit Experimenter upgrade.

The folks at Microchip have created a PIC32MX2/MX1 chip that is a 28-pin SDIP which is pin-compatible to the Experimenter. With this simple chip replacement and the new MPLAB X IDE and free PIC32-bit C compiler, you can easily transition to 32-bit processing.

Let's call the new configuration the "16x2 Experimenter" to usher in a new era for 32-bit Experimenter processing power. Sound interesting? Well, we are going to walk you through this. As an added feature, we will also briefly cover the newly released MPLAB X IDE, and show how this — along with the 16x2 Experimenter — can work in a series of 32-bit processing demos using either the PICkit3 or the Microstick II series of programmer/debuggers. All the demos are written in C code using the PIC32 library. Explanations will be kept straightforward, but some familiarity with C programming is required.

Let's kick it all off with an in-depth look into the PIC32MX2 microcontroller before launching MPLAB X and the demos.

The New Microchip PIC32MX2 Microcontroller — An Overview

The PIC32 32-bit microcontroller is the top performer in Microchip's product family. The PIC32 offers significant enhancements in speed and performance over all the other members of the Microchip product family. If you require high-end performance for your microcontroller application and want to explore the best in class for 32-bit microcontrollers, then the PIC32 is the processor for you.

Microchip recently released their new PIC32MX1 and MX2 series (see **Figure 2**). This small form factor PIC32 comes in a skinny DIP 28-pin part, and is our ticket for an Experimenter upgrade. To understand the significance of

the upgrade, let's compare the PIC32MX2 to the PIC24FJ64GA002 (the original 16-bit microcontroller used on the Experimenter), then to the PIC16F887 (a widely used eight-bit microcontroller).

In **Table 1**, the MIPS (Millions of Instructions Per Second) metric is used to capture execution performance. As illustrated, the PIC32 runs 2X faster than the PIC24F, and 5X faster than the PIC16. The PIC32MX2 also executes instructions with 32 bits, versus 16 and eight bits used by the other family members.

Note the block diagram of the PIC32 internals in **Figure 3**. Like the PIC24F, it is also a +3.3V part; however, it can accept +5V logic level inputs on certain pins without damage. The PIC32 has two internal busses. The top bus is the faster of the two and runs at the system CPU clock rate. This bus allows simultaneous communications for devices without bus contention. Devices on this bus are the 32 Core CPU, the eight channel DMA (Direct Memory Access) controller, and USB. Other components on this bus are Flash, RAM, an interrupt controller, all the digital ports, and a peripheral bridge (a connection to all the on–chip peripherals). It is interesting to note that digital ports reside on the high speed bus. This means they can be toggled (on/off) at the 40 MHz rate, to be able to generate digital signals of up to 20 MHz if needed. With the use of DMA, this port (or any other peripheral) can access memory directly without CPU (software) intervention for data transfers.

The other bus is the peripheral bus that connects to all the on-chip peripherals. It does not need to run as fast as the previous bus, and can be slowed down to a factor of 1 to 8 (peripheral clock rates are not required to be run as high as 40 MHz). On this bus, there are five 16-bit timers, an RTCC (Real Time Clock Calendar), two UARTs (Universal Asynchronous Receiver Transmitters), two SPIs (Serial Peripheral Interfaces), two I^2Cs (Inter-Integrated Circuits), 13 channel 10-bit ADCs (Analog-to-Digital Converters), one PMP (Parallel Master Port), five CCP (Compare/Compare Ports), three analog comparators, and the new CTMU (Charge Time Measurement Unit) peripheral.

Upgrading the Experimenter

A block diagram of the Experimenter is shown in **Figure 4**. The only real change is the replacement of the existing PIC24F 16-bit part with the PIC32MX2 32-bit part. It is that simple. The rest of the hardware remains the same because the folks at Microchip have maintained a common pin-out and functionality across the device class of 28-pin SDIP microcontrollers. This fact also allows the Experimenter to use not only the PIC32MX2, but also the new advanced dsPIC33, PIC24H 16-bit machines. Note that because the PIC32MX2 PPS (Programmable

FIGURE 2. Microchip's new PIC32MX 2 small form factor.

PIC32MX2	PIC24F	PIC16
32-bit	16-bit	Eight-bit
32 Flash	64K Flash	8K Flash
8K RAM	8K RAM	386 RAM
40 MIPS	16 MIPS	5 MIPS
3.3V operation	3.3V operation	5V operation

Table 1.

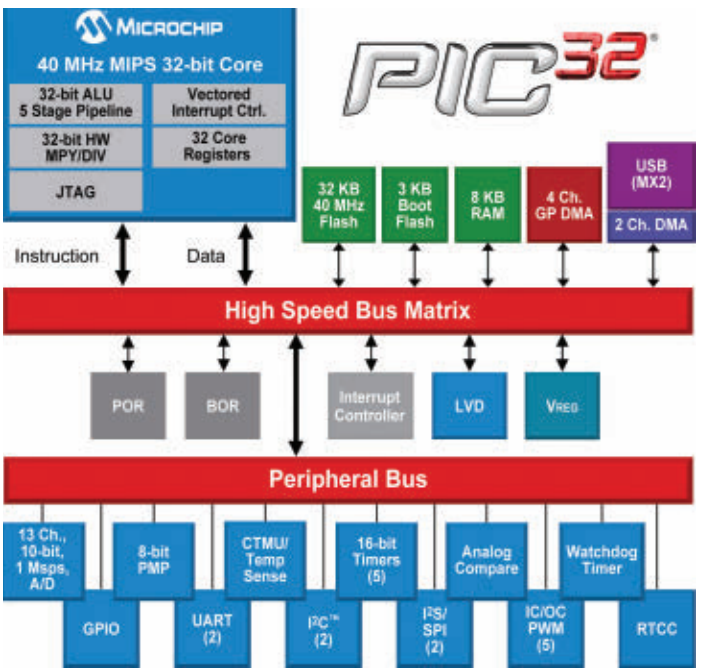


FIGURE 3. PIC32MX block diagram.

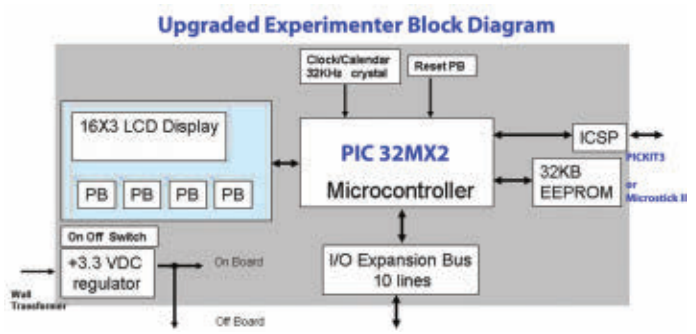


FIGURE 4. The 16x2 Experimenter block diagram.

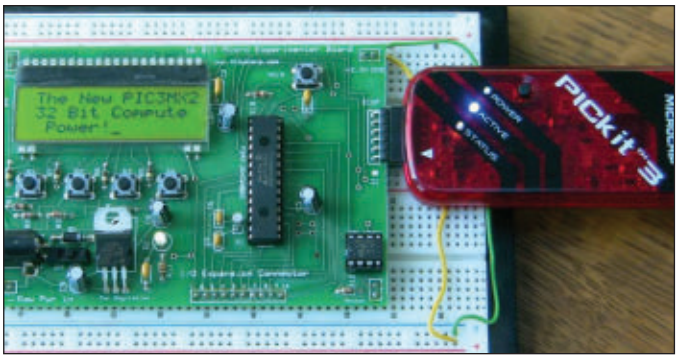


FIGURE 5. The 16x2 Experimenter using PICkit3.

Peripheral System) is slightly more restrictive than the 16-bit family's PPS, the Experimenter 32KB EEPROM cannot be accessed onboard by the PIC32MX2.

To access it, you must remove it from the board, plug it into a solderless breadboard, and use the I/O expansion bus for connection. (If you'd like some help with these new advanced 16-bit processors, *Nuts & Volts* is offering a new book, the *Beginner's Guide to Programming the PIC24H/dspPIC33* that focuses on these 16-bit parts.)

Programming and Debugging Options

The PICkit2 originally used with the 16-bit Experimenter does not support the new PIC32MX parts. Some low cost options that are available include the PICkit3 or the new Microstick II programmer/debugger. The PICkit3 uses the existing 16x2 Experimenter ICSP interface in the same manner as the PICkit2. It just plugs in from the side (see **Figure 5**). The Microstick II is made for directly plugging into solderless breadboards. With an adapter, it can plug directly into the 16x2 Experimenter processor onboard CPU socket and function as the debugger/programmer (see **Figure 6**). This adapter (see **Figure 7**) is also available from the *Nuts & Volts* webstore.

As with the PICkit3, the adapter requires external power to the Experimenter. To use the adapter, you need to remove the existing Experimenter microcontroller from its socket to enable plug-in; make sure the Microstick II is using the PIC32MX2. Both the PICkit3 and Microstick II with adapter work directly with MPLAB X.

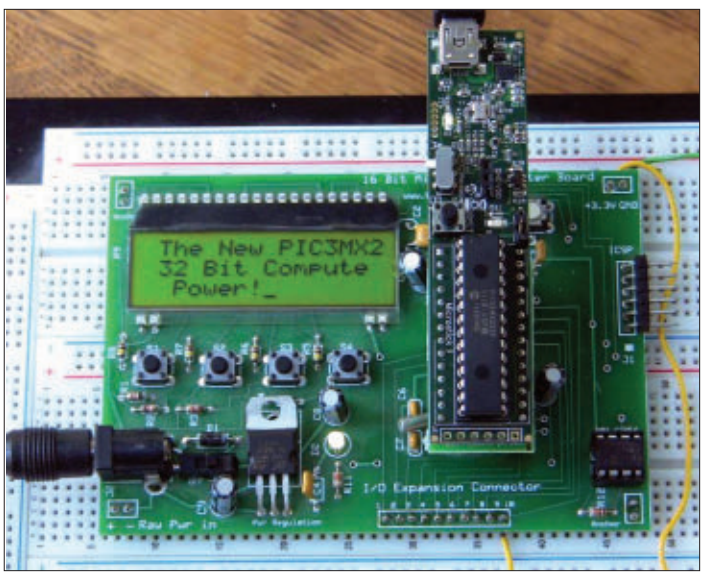


FIGURE 6. The 16x2 Experimenter using Microstick II.

MPLAB X

MPLAB X (see **Figure 8**) has become all the rage with the electronics community, and has recently received several industry awards. MPLAB X represents a significant departure from Microchip's existing 8.xx IDE series. It is part of a movement to open source framework based on Java NETBEANS versus proprietary based custom designed software. With MPLAB X, a whole new series of tools are made available, as well as potential enhancements from third party vendors. MPLAB X is required when using the new PIC32 MX2 parts. Some new MPLAB X features are:

- One-click make, program, and debug/execute operation.
- Support for multiple configurations within projects.
- Support for multiple debug tools of the same type, as well as support of multiple versions of the same compiler.
- Easy import of existing MPLAB 8 projects.
- Tracks changes within users own systems using local history.
- "Tasks" window to keep track of "loose ends" in code.
- New all-encompassing "Project Status" window.
- New "Navigation" window for fast, easy access to code.
- Built-in source code control.
- A new call graph feature for navigating complex code.

MPLAB X can reside with MPLAB-8.x.x installs, so you can retain both sets of tools. MPLAB X can be downloaded from **www.microchip.com/pagehandler/**

en-us/family/mplaBX. It is aware of all the other Microchip system compilers and optional tools you may have installed on your system, and allows these components to exist simultaneously without conflict. You can set which component or tool set to use during initial project builds and then update or change them using the project dashboard.

We will use MPLAB X for our demos. In addition, we will use a new version of the C32 compiler to support the PIC32MX2 part. This can be downloaded from **www.microchip.com/stellent/idcplg?IdcService=SS_GET_PAGE&nodeId=1406&dDocName=en534868**.

The Demos

There are three demos to help you gain familiarity with the new PIC32MX and MPLAB X with the16x2 Experimenter. These demos are briefly described here. The really cool thing about using the PIC32MX is that a lot of the original code written for the 16-bit microcontrollers can be directly ported to 32-bit operation with little modification. This is due in large part because of the compatibility that exists between the 32-bit and 16-bit on-chip peripheral set.

System.h contains all the PIC32 specific configuration settings and standard reference libraries (see below). For all the demos, a System.h is included in the project. It is here that the settings for the PIC32MX device configuration registers 3, 2, 1, and 0 are set and the reference is made to the PIC32 standard library. Note that all the demos are configured using the internal 8 MHz RC oscillator.

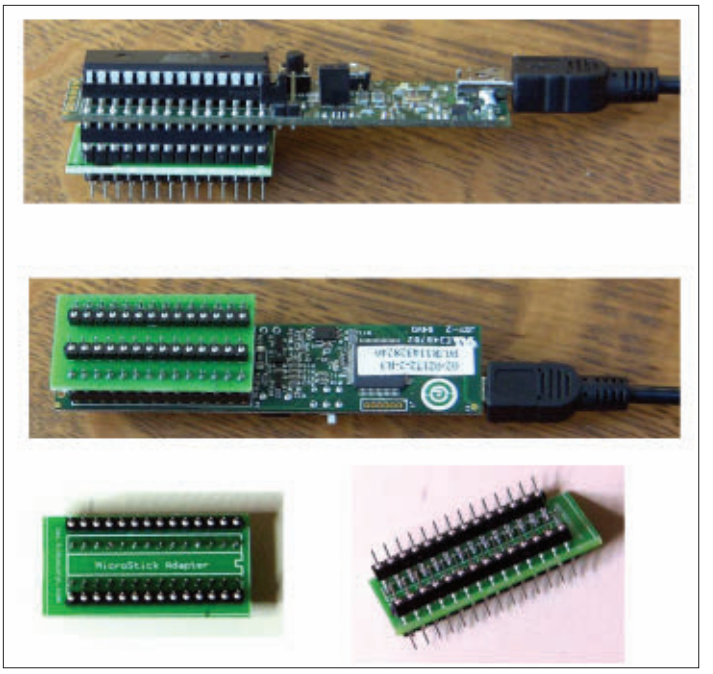


FIGURE 7. Microstick II adapter for the Experimenter.

FIGURE 8. MPLAB X.

```
#include <plib.h>
// DEVCFG3
// USERID = No Setting
#pragma config IOL1WAY = ON
// Peripheral Pin Select Configuration
// DEVCFG2
#pragma config UPLLEN = OFF
// USB PLL Enable (Disabled and Bypassed)
// DEVCFG1
#pragma config FNOSC = FRC
// Oscillator Selection Bits Fast RC 8MHZ
#pragma config FSOSCEN = ON
// Secondary Oscillator Enable (Enabled)
#pragma config IESO = OFF
// Internal/External Switch Over (Disabled)
#pragma config POSCMOD = OFF
// Primary Oscillator Configuration
#pragma config OSCIOFNC = OFF
// CLKO Output Signal Active on the OSCO Pin
#pragma config FPBDIV = DIV_1
// Peripheral Clock Divisor
#pragma config FCKSM = CSDCMD
// Clock Switching and Monitor Selection
#pragma config FWDTEN = OFF
// Watchdog Timer Enable
// DEVCFG0
#pragma config JTAGEN = OFF
// JTAG Enable (JTAG Disabled)
#pragma config ICESEL = ICS_PGx1
// ICE/ICD Channel Select
#pragma config PWP = OFF
// Program Flash Write Protect (Disable)
#pragma config BWP = OFF
// Boot Flash Write Protect bit (Protection
// Disabled)
#pragma config CP = OFF
```

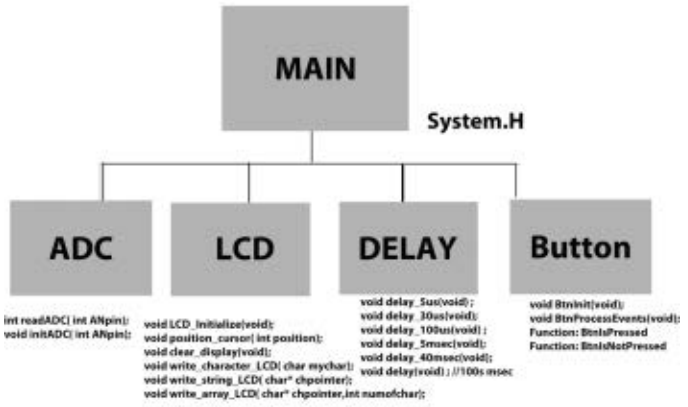


FIGURE 9. Custom 'C' library and associated API.

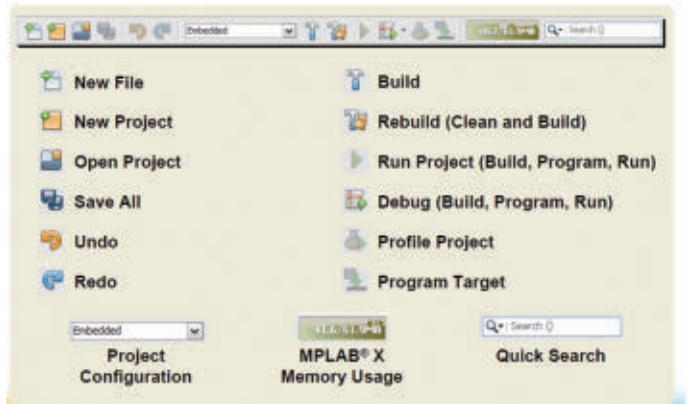


FIGURE 10. MPLAB X main tool bar icon description.

FIGURE 11. MPLAB 8 to MPLAB X debugger icon comparison.

The demos also use a number of 'C' custom library functions, as well as the standard PIC32 reference library. A pictorial of the custom library collection is shown in **Figure 9**. Each demo uses a combination of these library elements. The unique code for each demo is really carried out in "Main."

The custom libraries are pretty self-explanatory. The ADC library handles initializing the 10-bit ADC in the PIC32 for one of its 13 channels, and then collects sampled data from that channel. The LCD library allows for initializing of the LCD, clearing the display, setting the cursor position, and writing to the display.

The DELAY library provides for a number of software-based delays that are used through the library and in Main. The BUTTON library handles initializing digital input for four buttons, and then debouncing and reading button states.

Demo software is provided in the form of three MPLAB X projects, as described below.

1. BUTTONDEMO (LCD and buttons): This is a basic demo that starts with a splash display highlighting the new PIC32 part and its capabilities. It then prompts the user to push a button and then displays which button was pressed. Uses LCD, Delay, and Button libraries.

2. ADCDEMO (ADC operation): This is a demo of the PIC32MX2 10-bit ADC using the ADC library. A 10K potentiometer is required to be wired up with wipers connected to pin 10 of the Experimenter J3 expansion I/O connector (see the board silkscreen in the downloads for actual pin position). The other two ends of the potentiometer are wired to +3.3 VDC and ground from the Experimenter (again, see the board silkscreen for +3.3V and ground output pins). The display will automatically update the ADC count and ADC voltage as the potentiometer position changes. Uses ADC, LCD, and Delay libraries.

3. PWMDEMO (LED dimmer operation): This demo uses the ADC and the PWM output from the Output Compare module 2 (OC2) to control brightness to an LED. A potentiometer is hooked up to the Experimenter as in #2 above. In addition, OC2 is configured using PPS for pin 5 of J3 (see the board silkscreen for actual pin position). Also on pin 5 J3, a 470 ohm resistor in series with an LED anode (with the cathode to ground) is needed. As you rotate the pot, the PWM to the LED changes duty cycle from 100%-0%, thereby affecting its brightness. The Main code illustrates the use of the Programmable Peripheral System (PPS) feature of this device by allowing a user to configure a programmable pin with a peripheral output. In this case, RB8 is configured for an OC2 peripheral. Use of the PIC32 peripheral library for selecting OC2 under PPS and enabling it (as well as setting pulse width for PWM) is demonstrated here. The project also uses ADC, LCD, and Delay Libraries.

Using MPLAB X

MPLAB X is new and there are a lot of features — way too many to cover here. So, since pictures are worth a

Haven't got your Experimenter yet? Well, you're in luck!
It can be purchased online from the
Nuts & Volts Webstore at www.nutsvolts.com
or call our order desk at 800-783-4624.

thousand words, let's walk through some of the major tool bars. If you are familiar with the current MPLAB 8.xx series of Microchip's IDE, there are similarities that will help you get started. **Figure 10** shows the main tool bar. Here, we have quite a few similar functions to the existing MPLAB 8.xx tool bar, but the new one uses different icons.

Figure 11 is a side-by-side comparison of the debugger tool bars. **Figure 12** shows the Editor tool bar with its new icons, but with additional functionality that was not present in MPLAB 8.xx.

Working With the Demos

The demos have already been configured for you as MPLAB X. To open a project, you navigate to the folder of the project demo you downloaded, and open the X extension as shown in **Figure 13**.

The demos are configured with specific compiler selections and the PICkit3 debugger. You may have to change these for your system's compiler locations and debugger selection. (We will show you how.) You will still need to apply power to the Experimenter board and add any additional hardware the project may require. Then, simply compile, download, and run.

As you open each of the projects, you will find that MPLAB X supports multiple projects. The screenshot in **Figure 14** shows MPLAB X once all the demos have been opened. Each project is organized into file folders designated as: Header, Library files, Linker files, Object files, Source files, and Important files. We use both the header and source folders. You select which project (in the project window) to make active by right-clicking your mouse on the project tile and selecting it as your active main project. In this case – within the Projects window – PWMDEMO is selected and the main file in the source folder for PWMDEMO is open in the Edit Window. The Output window is also shown. It is displaying the results of the last build.

MPLAB X has a new all-inclusive Project view with the Dashboard view. Under "Window" on the tool bar, select Dashboard and you should see what's shown in **Figure 15**. With one view, you see the device, compiler tool chain, memory utilization, active breakpoints, and debugging tools. On the left side of the dashboard are several other important icons. When clicked, the PDF image automatically displays the device's datasheet; when selected, the circular arrow icon resets the device; when selected, the wrench icon brings up another window to allow you to change any of the major settings in the project. Refer to **Figure 16**.

Under this window, you can switch debuggers between Microstick II and PICKIT3, or even select a different compiler.

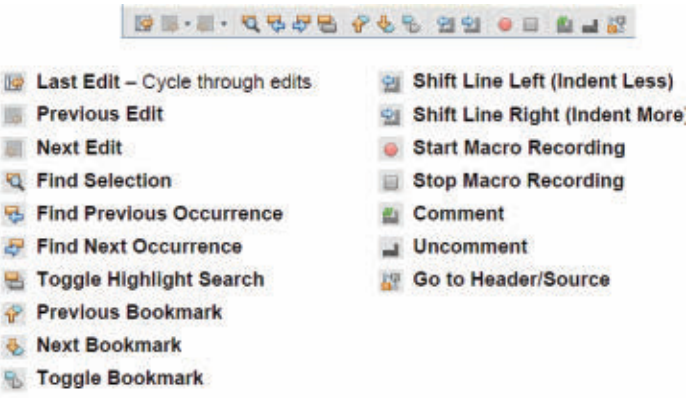


FIGURE 12. Editor tool bar.

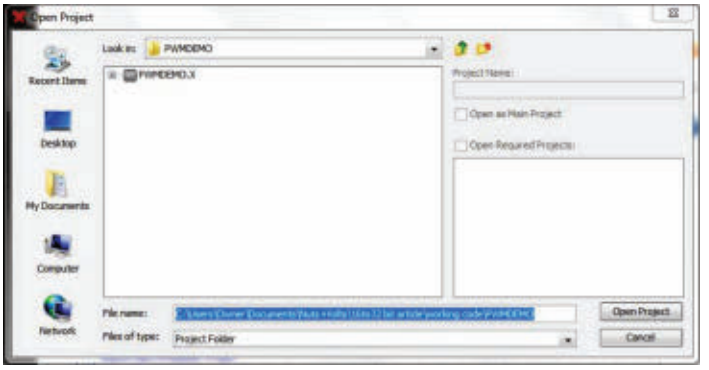


FIGURE 13. Opening a demo project.

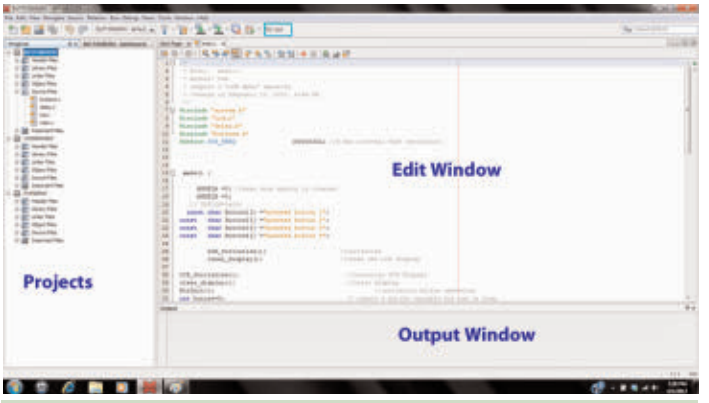


FIGURE 14. MPLAB X with demos.

Ideas for the Future

Now that we have covered an important 32-bit upgrade for the Experimenter while also illustrating a new set of tools and methods, we hope you will be anxious to try it yourself. The Experimenter remains a viable learning

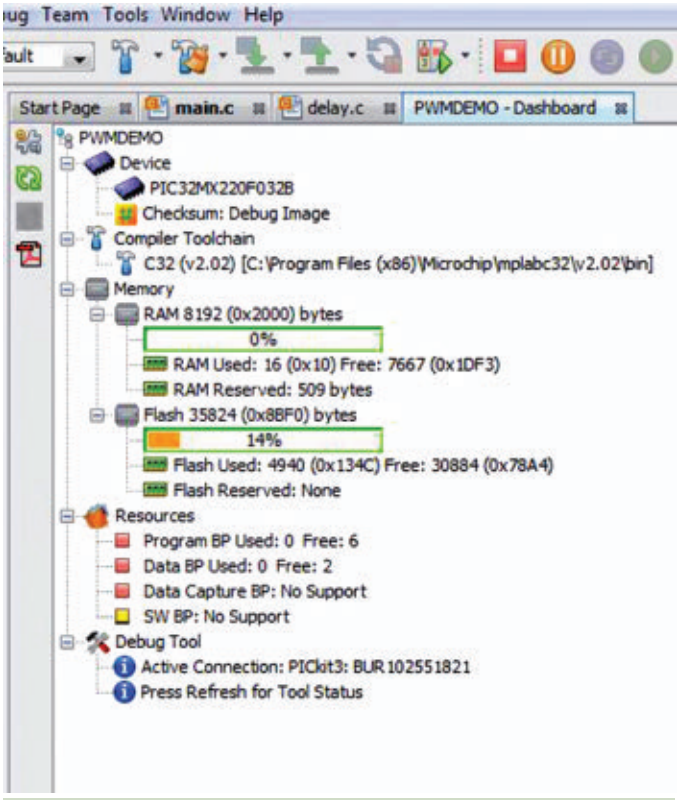


FIGURE 15. Dashboard.

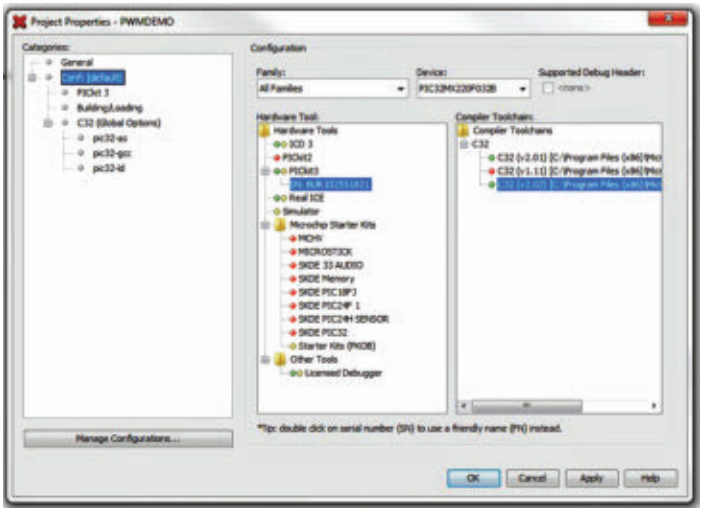


FIGURE 16. Changing project settings.

tool that is easily adapted to new technologies. We have touched on many areas including the new MPLAB X and Microstick II. For those wanting to use the Microstick II with the Experimenter in place of the PICkit 3, an adapter is provided. Working the software demos will help to solidify your understanding of both the PIC32MX2 and MPLAB X. But we are not done! In fact, we are just touching the surface! **NV**

READER FEEDBACK

Continued from page 9

Thanks Phil. I appreciate the feedback. I know the German mentality. I spent a year there a while back and was there again recently. I somehow suspect that modern bomb makers may not be so disciplined, but I certainly don't want to find out.

Bryan

Recycling Parts

I found Bryan Bergeron's editorial on component defects interesting. I have been recycling several hundred thousand parts a year in my hobby/business since 1977. I have found that while electrolytic capacitors have a definite deterioration over time, many ICs and other durable parts (flameproof resistors) and the like have a life span of many years. I probably have 100,000+ semiconductors that I would like to think will outlast any storage. If I knew of a definite rate of deterioration of these parts, I would radically change my views on salvage. Some technician friends of mine have suggested that these salvaged parts aren't as good as new, however, I have found that if they were good parts to begin with, then they would be suitable for reuse. Also, I contend that parts of older manufacture are better. Case in point: Many older electronics from the '70s and earlier are still functioning well, while newer ('90s and beyond) components have already failed. So, I believe we have a definite deterioration in manufacturing reliability. Also, newer electronics that contain SMDs are not economically viable for reuse.

Mike Jobe

Thanks Mike. I appreciate the feedback and agree with you on current 'quality.' Even though I have a hot air reworking station, I rarely salvage anything useful from an SMD board.

Bryan

Ham Fodder

As an ARRL VE (volunteer examiner), please allow me to correct a few points in Louis Frenzel's fine article in the April '12 issue about how to get your ham radio license.

First, the cost to take the exam is determined by the VEC (volunteer examiner coordinator). The current cost to take the test through the ARRL is $15. The fine gentlemen who give the ham tests at the Dayton Hamvention operate through the Laurel VEC and they charge the princely sum of $0. That's right, nothing. VEs are not commissioned by the FCC. The VEC groups are, and they then register their VEs. One can be a VE for more than one VEC.

There are currently five classes of license, two of which are grandfathered and are not available to new or upgrading licensees. These are Novice and Advanced.

As a new licensee, you are required to pass the Technician Element 2 before you attempt the Element 3 General test, but you do not need to "get some experience" before you can try. In fact, I routinely suggest to those who pass Element 2 at a test session I run that they should try for General. Why not? They're at the test site, they've already gone through the registration process, and after passing the Tech test they can try the General for free!

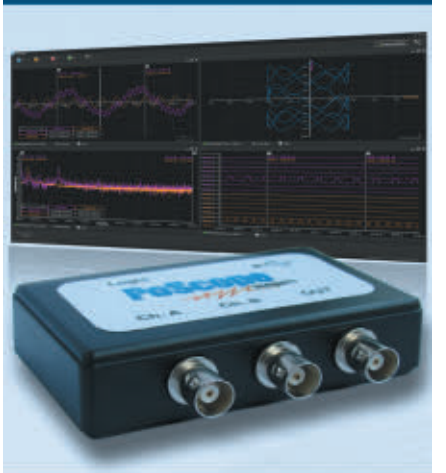
Finally, even the lowly Technician can apply for a vanity callsign. They cannot get the highly prized 1x2 calls that Amateur Extras can, but they have the pool of 1x3 and 2x3 to select from. So, if you're going for your test and are good at memorizing or are already proficient in electronic theory, you really should scan the General questions ahead of time and take a shot. You have nothing to lose other than a half hour or so of your time. I'm happy to take the time grading your exam because I also like shaking someone's hand and saying "welcome, new ham."

John Stanley N8GFO

Thanks for clarifying the details of getting a ham license. Even those of us who should know this have trouble in understanding the complex process

Continued on page 63

Need a small and cost-effective device?
Look no further.



PoScope Mega1+

Smallest USB 2.0 portable 1MS/s oscilloscope
Data acquisition of analog and digital signals
Data recording
Export to CSV, XLS, PDF and HTML
Simple usage of advanced features
Examples for C++, VB, Delphi and LabView
Free software and updates

PoKeys 56

Smallest USB HID or ETHERNET I/O interface
Keyboard and joystick simulator (USB)
55 digital I/O (configurable)
LCD and LED matrixes driver
6 PWM outputs, 26 encoder inputs
Supports up to 10 I2C, 1-Wire sensors, up to 7 analog sensors
Expandable with PoNet
Free software and web interface (Ethernet)

Visit www.poscope.com

PoLabs

#48 SMILEY'S WORKSHOP

C PROGRAMMING - HARDWARE - PROJECTS

by Joe Pardue

Discuss this article in the *Nuts & Volts* forums at http://forum.nutsvolts.com.

It's About Time

Recap

Last month, we learned some theory about C arrays and then did a lab project that used the Simple Chaser Lights kit to build a POV (Persistence Of Vision) wand. This month, we are going to look at some C theory for structuring data and then do some hands-on lab work using a DS1307 real time clock IC on a breadboard.

"Does anybody really know what time it is? Does anybody really care?"

The Chicago Transit Authority, 1969.

Well, I for one care, and I have read enough of the physics and philosophy of time that I can safely say I don't have a clue what time it is. Before I did all that reading, I thought I knew what time is. Now, I'm befuddled. I'm pretty sure time has to do with things falling apart (which is verified by my mirror), but beyond that ...

For this article, let's settle on the Wikipedia definition that *time is what clocks measure*. Since computers have clocks, let's start to learn about those clocks and how to use C to keep track of time.

C Theory

C provides some features that help us organize and manipulate data. We've already looked at how arrays help us work with large blocks of data of a single type. We use some concepts that duplicate what we could do with pointers, but make the work somewhat more intuitive than pointers and therefore easier. Remember that in C, the name of an array is equivalent to the address of the first element of that array. This is the same as a pointer is to the first element of a section of memory. We can use arrays which we may already be familiar with from our math studies (for many folks, arrays seem like obvious ways to group data) or we can use pointers to do the same thing in a much less intuitively friendly fashion.

Let's look at a couple of other C features that will help us deal with data: enums and data structures. Enums are simple and only occasionally needed; data structures can be quite complex and are used everywhere in C to handle all but the simplest work with data. We will learn about these using examples that we will run under Pelles C to help us master the concepts. [Pelles C was introduced in Smiley's Workshop in the June '09 *Nuts & Volts*. You can get a copy from **www.smorgasbordet.com/pellesc**.] Then, we will see how these concepts can be used in actual examples of computer time keeping. These high level software data handling concepts for manipulating data — when applied to time as that data — will soon lead us to some very low level hardware concepts involving the AVR timer/counter peripherals. This is another case where it is difficult to know the order to present the information, so bear with me. Hopefully, things that seem to be presented out of sequence will eventually start to line up and make sense.

Enums

The C keyword enum (from enumeration) conveniently provides a way to give names for constant sequential numbers. Enums let you think of the data as a name, not a number, and lets the computer worry about the number for you. For instance, you might say:

```
enum boolean { NO, YES }; // NO is 0, YES is 1
```

The computer will automatically assign the number 0 to NO and the number 1 to YES. You can then use these names in the code. For instance, you might query a user with a yes or no question and call one of three functions depending on the answer:

```
if (answer == YES) sheSaidYes();
else if (answer == NO) sheSaidNo();
else sheIgnoredYou();
```

You could just as easily use:

```
#define NO 0
#define YES 1
```

Theory is all well and good, but to really learn this stuff you have to get your hands on some tangible items that blink, whirr, and sometimes detonate. As a service for the readers of the Smiley's Workshop articles, we have simple and inexpensive projects kits available that can help you make it real. You can find these kits (and some darn good books) at the *Nuts & Volts* Webstore.

Nuts & Volts now carries the entire line of Smiley Micros books and kits. Some are shown in the magazine and others in their web shop. If you just can't wait and want to get a leg up on real C programming for the AVR (while helping support your favorite magazine and technical writer), then buy my C Programming book and Butterfly projects kit, or if you are a complete novice try *The Arduino Workshop* and projects kit.

Questions? *Nuts & Volts* is hosting forums for its writers and you can find mine at **http://forum.servomagazine.com**. If you want a really quick response — especially to a question not directly related to an article — you could put on your biohazard suit and start a thread on **www.avrfreaks.net**. Read my blog entry first that will tell you why you need the biohazard suit at **http://smileymicros.com/blog/2011/01/24/using-an-internet-forum**.

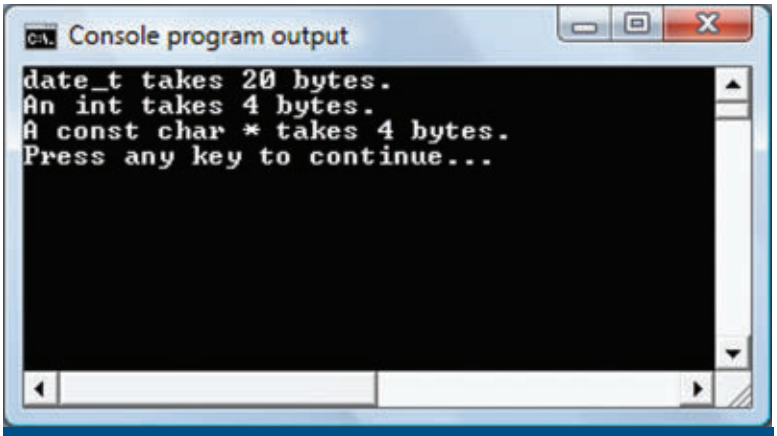
Enums come in really handy when you want to assign a longer sequence of words that naturally associate with sequential numbers, such as many words that are used in time keeping. For instance, the month of the year. We might write a date as 5/6/12 or we might write it as May 6, 2012. The 5 and May are equivalent. (This is true in America, but other countries list numerical dates differently so they may think 5/6/12 is actually 5 June 2012.)

When you define a sequence of names in an enum, the default behavior is for the first name to be defined as 0. If you specify a number for the first, the enum will assign the numerical sequence that follows for the rest of the numbers. For example:

```
enum months { JAN = 1, FEB, MAR, APR, MAY, JUN,
JUL, AUG, SEP, OCT, NOV, DEC };
```

If you are dealing with a calendar, you don't care what the number of the month September is, you just want to deal with September. A simple example for using this follows:

```
#include <stdio.h>

enum months { JAN = 1, FEB, MAR, APR, MAY, JUN,
JUL, AUG, SEP, OCT, NOV, DEC };

int main(int argc, char *argv[])
{
  enum months myMonth;
  int mth,oldMth;
  int go = 1;

  printf("Enter 0 or any number > 12 to
  exit\n");

  while(go)
  {
    printf("What is the number of the month you
    were born?\n");

    oldMth = mth;
    scanf("%d",&mth);

    if(oldMth != mth)
    {
      myMonth = mth;

      switch(myMonth)
      {
        case JAN:
          printf("You were born in January\n");
          break;
        case FEB:
          printf("You were born in
          February\n");
          break;
        case MAR:
          printf("You were born in March\n");
          break;
        case APR:
          printf("You were born in April\n");
          break;
        case MAY:
          printf("You were born in May\n");
          break;
        case JUN:
          printf("You were born in June\n");
          break;
        case JUL:
          printf("You were born in July\n");
          break;
        case AUG:
          printf("You were born in August\n");
          break;
        case SEP:
          printf("You were born in
          September\n");
          break;
        case OCT:
          printf("You were born in October\n");
          break;
        case NOV:
          printf("You were born in
          November\n");
          break;
        case DEC:
          printf("You were born in
          December\n");
          break;

        default:
          printf("What, were you hatched?\n");
          go = 0;//
          break;
      }
    }
  }
}
```



■ FIGURE 1. Size of date_t.

You can find this example in the source code file at the article link.

Structures

A structure is a collection of variables that may be of different data types, all grouped together under a single name. This is similar to an array that groups data under a similar name and locates it in contiguous memory. Unlike an array in which all the data must be of the same type, a structure can have data of different types. They are like records in other programming languages and form a data unit that is convenient to handle. This convenience is very useful in large programs because it allows us to group related variables of different types and handle them as a unit rather than as individuals. It also allows us to pass the entire structure to a function by only passing the name of the structure which (like for arrays) is the address of (a pointer to) the first element of the data.

We usually declare structures near the start of a file or in a header. For example, we can declare structures for the date as follows:

```
struct date_t
{
  int year ;
  int month;
  const char *month_text;
  int day;
  const char *day_text;
};
```

This declaration tells the compiler that you want to store two ints, a constant character pointer (a pointer to a string), another int, and another pointer to a string all together in a package that you can handle as a unit. The compiler will determine how much memory space is actually needed to store this data. If our system defines an int as two bytes and the address of a string as four bytes, then this structure will occupy 14 contiguous bytes of memory. We don't need to know how the compiler defines these data types nor do we need to know how it allocates memory for it. Since we are curious folks, however, let's look to see how Windows stores this data. In Pelles C, write and run the following:

```
#include <stdio.h>

// Declare date_t
struct date_t
{
  int year ;
  int month;
  const char *month_text;
  int day;
  const char *day_text;
};

int main()
{
  struct date_t myDate;
// define an instance of date_t

  printf("date_t takes %d
bytes.\n",sizeof(myDate));
  printf("An int takes %d
bytes.\n",sizeof(myDate.year));
  printf("A const char * takes %d
bytes.\n",sizeof(myDate.month_text));
}
```

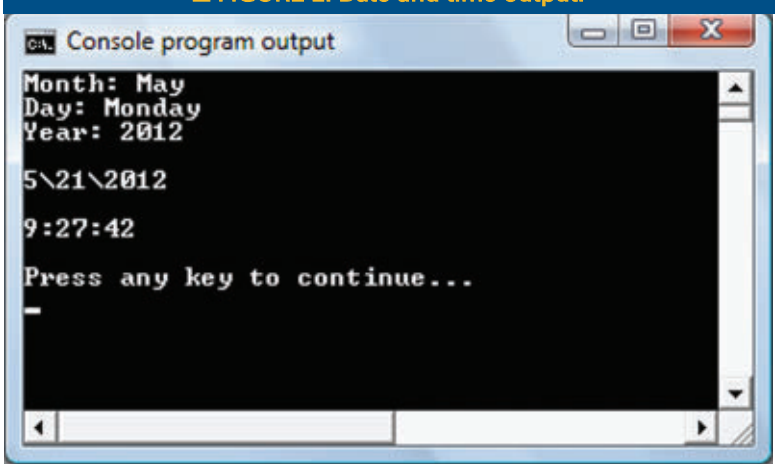
This results in the output shown in **Figure1**. So, I guessed wrong about the data sizes since an int is four bytes in Windows.

Notice in the above source code that the date_t structure is **declared** outside a function and **defined** within the function. The **declaration** tells the compiler what a date_t structure looks like; the **definition** creates a specific instance of that structure. You may also note that when we want to access a specific element of the structure, we use the **dot operator**, so we see myDate.year for the year element of the myDate structure. We'll see another way to access these elements later.

Now, we have the date aspect of date-time defined; let's look at the time aspect:

```
struct time_t
```

■ FIGURE 2. Date and time output.



```
{
  unsigned int hour;
  unsigned int minute;
  unsigned int second;
};
```

We might have an application like a real time clock that needs to use the date and time as a unit, so we can declare a structure that contains both the data and time structures — a nested structure — as follows:

```
struct rtc_t
{
       struct date_t myDate;
       struct time_t myTime;
};
```

At this point, we have declared three structures but we haven't created an instance of any of them. We have seen how to create an instance of a structure by defining it within a function. However, we could instead add a name following the final bracket to create the instance:

```
struct rtc_t
{
       struct date_t myDate;
       struct time_t myTime;
}myRTC;
```

This use does the same thing as writing the following in a function:

```
  struct rtc_t myRtc;
```

The difference is that the former creates an instance that is available to all functions in the module (the .c text file), while the latter creates an instance that is only available to the function in which it is declared. Either way, by declaring myRtc we are also declaring instances of the date_t and time_t structures.

As with arrays, we pass structures to functions using pointers. This requires that we use two sorts of operators to access the data in a structure. In the function where the structure was declared, we use the '.' operator. If we pass the structure to another function, we access the elements of the structure with the '->' operator. The following example creates an instance of rtc_t in main, then uses the '.' to load it with data. Next, it sends it to the function showDateTime, passing it as a pointer. In the function showDateTime, the data is accessed using the '->' operator.

```
#include <stdio.h>

struct date_t
{
  int year ;
  int month;
  const char *month_text;
  int day;
  const char *day_text;
};
```

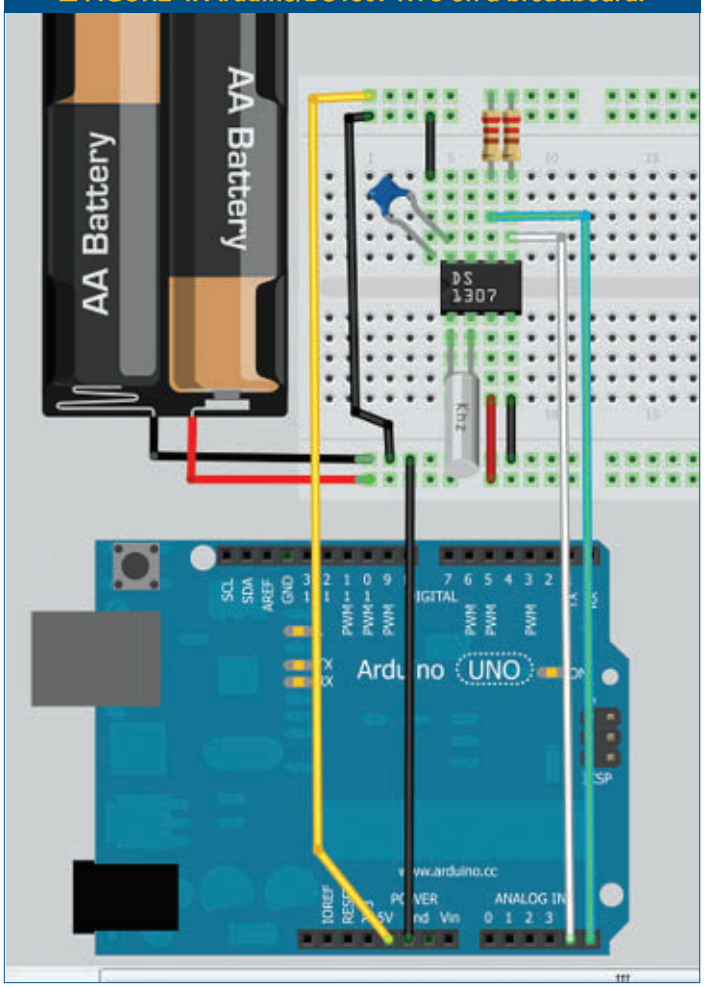
ADDRESS	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0	FUNCTION	RANGE
00h	CH	10 Seconds			Seconds				Seconds	00–59
01h	0	10 Minutes			Minutes				Minutes	00–59
02h	0	12	10 Hour	10 Hour	Hours				Hours	1–12 +AM/PM 00–23
		24	PM/ AM							
03h	0	0	0	0	0	DAY			Day	01–07
04h	0	0	10 Date		Date				Date	01–31
05h	0	0	0	10 Month	Month				Month	01–12
06h	10 Year				Year				Year	00–99
07h	OUT	0	0	SQWE	0	0	RS1	RS0	Control	—
08h–3Fh									RAM 56 x 8	00h–FFh

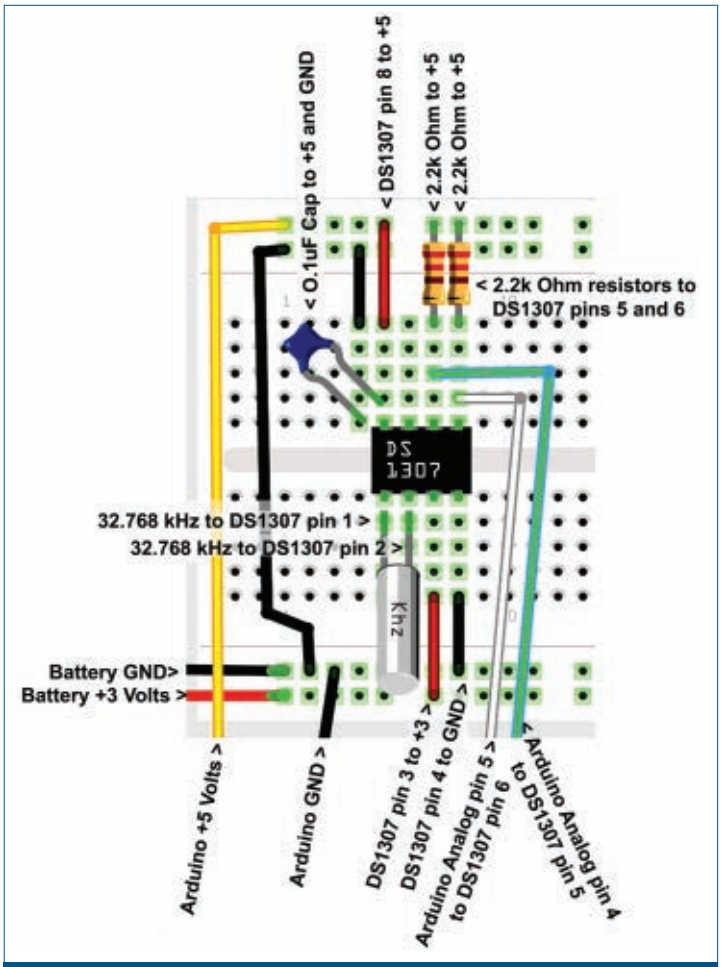
0 = Always reads back as 0.

■ FIGURE 3. DS1307 timekeeper registers.

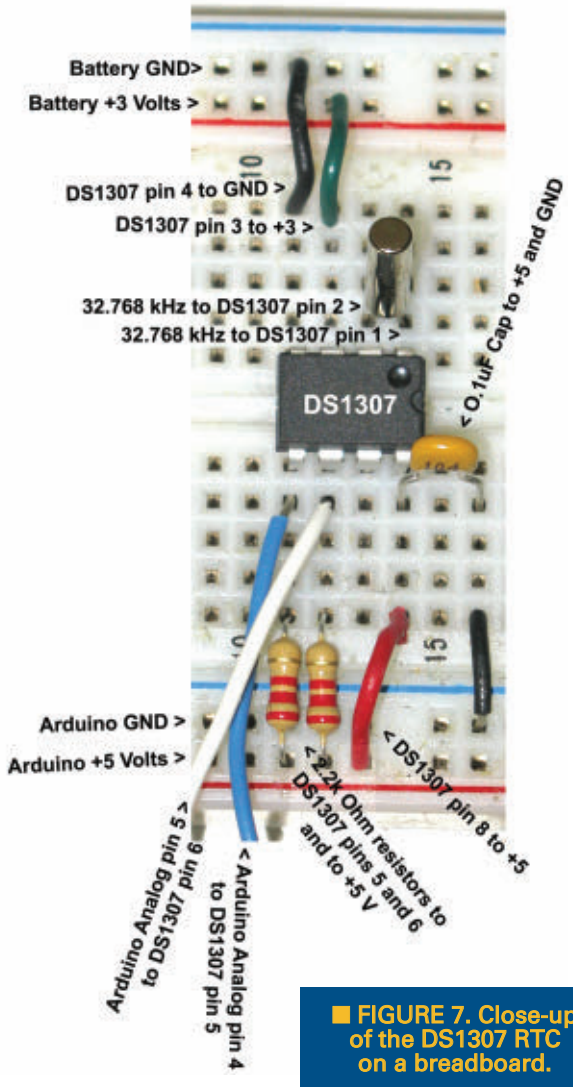
```
struct time_t
{
  unsigned int hour;
  unsigned int minute;
  unsigned int second;
};

struct rtc_t
{
  struct date_t myDate;
  struct time_t myTime;
};
```

■ FIGURE 4. Arduino/DS1307 RTC on a breadboard.



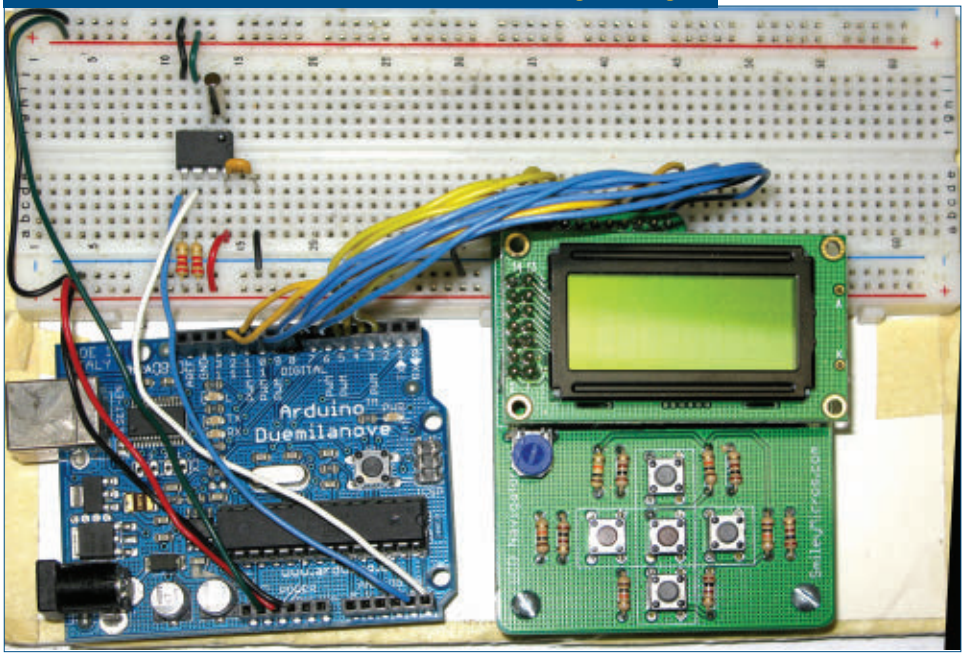


■ FIGURE 5. Breadboard wiring guide.



■ FIGURE 7. Close-up of the DS1307 RTC on a breadboard.

■ FIGURE 6. DS1307 RTC on a breadboard using Fritzing.




```
void showDateTime(struct
rtc_t *myRtc);

int main()
{
  // Declare an instance of
  // rtc_t
  struct rtc_t myRtc;

  // Load it with data
  myRtc.myDate.year = 2012;
  myRtc.myDate.month = 5;
  myRtc.myDate.month_text =
  "May";
  myRtc.myDate.day = 21;
  myRtc.myDate.day_text =
  "Monday";
  myRtc.myTime.hour = 9;
  myRtc.myTime.minute = 27;
  myRtc.myTime.second = 42;

// Send the address-of to
// show the date and time
  showDateTime(&myRtc);
}

// Take a pointer to an rtc_t
structure and show the data
```

```
void showDateTime(struct rtc_t *myRtc)
{
  printf("Month: %s\nDay: %s\nYear: %d\n\n",
    myRtc->myDate.month_text,
    myRtc->myDate.day_text,
    myRtc->myDate.year);

  printf("%d\\%d\\%d\n\n",
    myRtc->myDate.month,
    myRtc->myDate.day,
    myRtc->myDate.year);

  printf("%d:%d:%d\n\n",
    myRtc->myTime.hour,
    myRtc->myTime.minute,
    myRtc->myTime.second);
}
```

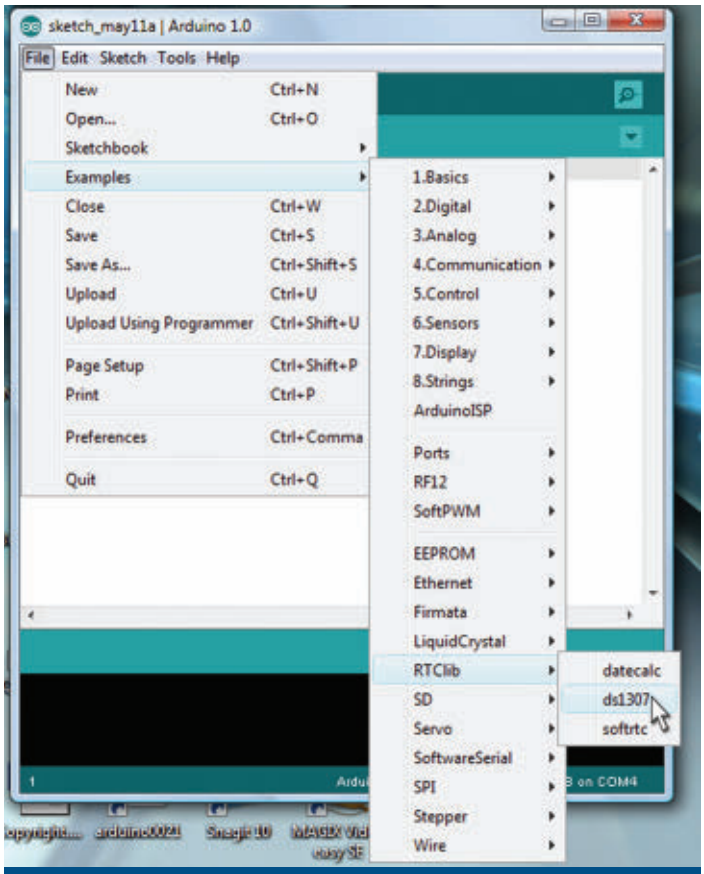
Take a moment to review that code and think about the two methods for accessing the data in a structure. When you are dealing directly with the structure, you use the dot '.' operator. When you are dealing with a pointer to the structure, you use the arrow '->' operator. When you are dealing with structures within structures as shown in our example, you use the '->' for the outer structure which was passed as a pointer and the '.' for the inner structures that got passed along with it. You have to use this a bit to get comfortable with it.

Lab

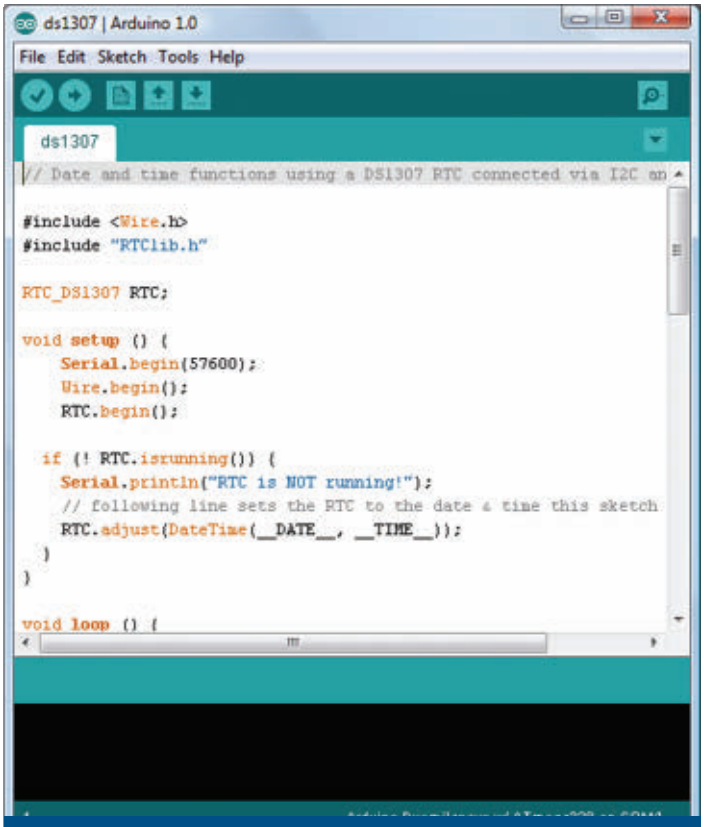
The PC has a real time clock (RTC) that has its own battery so that it can keep running — even when the PC is unplugged. With microcontrollers, we have to add hardware to make an RTC. In the AVR Butterfly, a 32.768 kHz watch crystal is attached to an internal AVR timer/counter peripheral so that an interrupt can be generated every second to keep count of seconds. Another way to do this is to have an external IC to keep time for us; we can then ask that device for the time. One common device used for this is the DS1307 that requires one of those 32.768 kHz crystals. It can communicate with a microcontroller via an I²C bus. This month, we will build an RTC on a breadboard for use with an Arduino that conveniently has an RTC library already written for us. We will then add a PCB to this kit (DS1307RTC kit) that you can purchase from the *Nuts & Volts* Webstore. In a later Workshop, we will take a deeper look at computer time-keeping that will lead us to writing a C based time-keeping library and to learning about the AVR timer/counter peripherals.

How the DS1307 Stores Date and Time Data

The DS1307 has 64 registers in SRAM — the first eight bytes are used to store the time data; the next 56 are available for your use (more on that later). Take a look at the first byte 00h that is used to store seconds. You see that the four lower bits store seconds, while the next higher three bits store '10 seconds.' You might wonder what that is all about since you can, in fact, store all the



■ FIGURE 8. Arduino select RTCLib DS1307 sketch.



■ FIGURE 9. Arduino DS1307 sketch.

Qty	Name	Mouser Part Number
1	DS1307	700-DS1307
1	32.768 watch crystal	815-AB38T-32.768KHZ
1	Battery holder 12 mm coin	534-3001
1	Battery CR1220	614-CR1220
1	Capacitor 0.1 µF	21RZ310-RC
2	Resistor 2.2K ohm	660-MF1/4DCT52R2201F

Table 1. Bill of Materials.

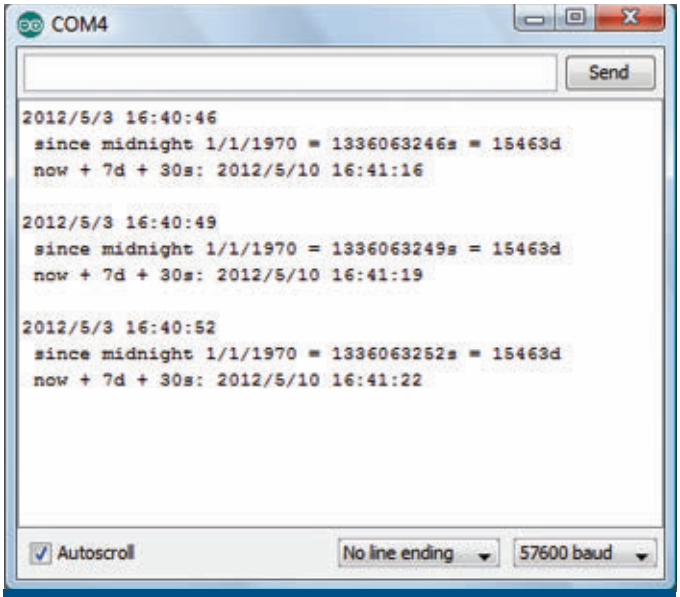


FIGURE 10. Arduino DS1307 sketch output in a serial monitor.

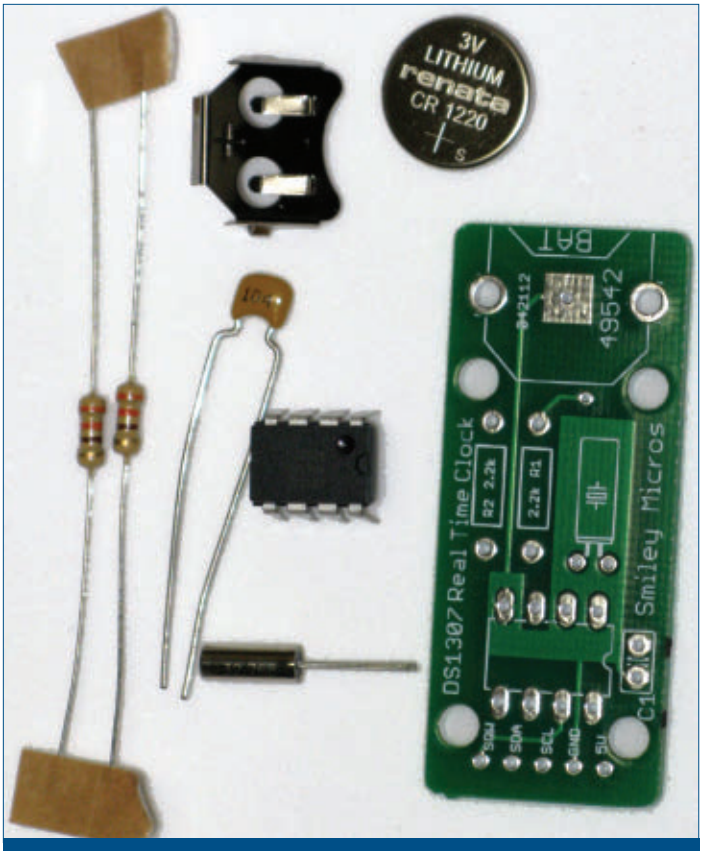
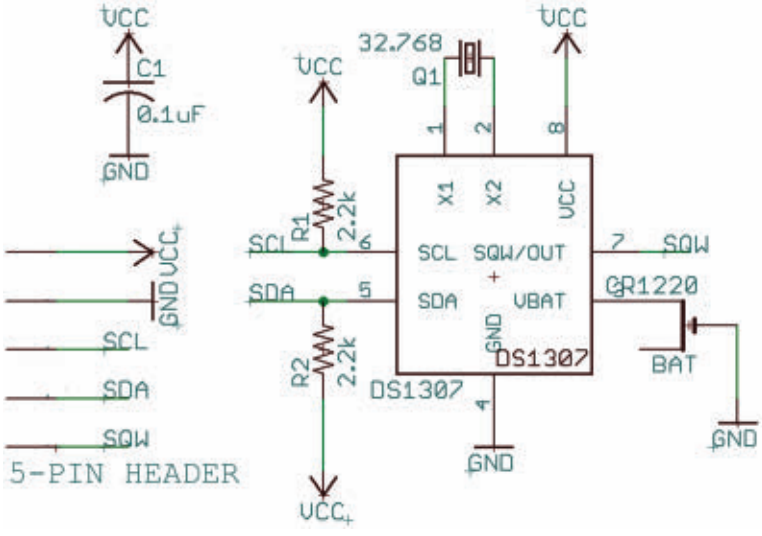


FIGURE 12. DS1307-RTC parts kit.

FIGURE 11. DS1307 RTC schematic.



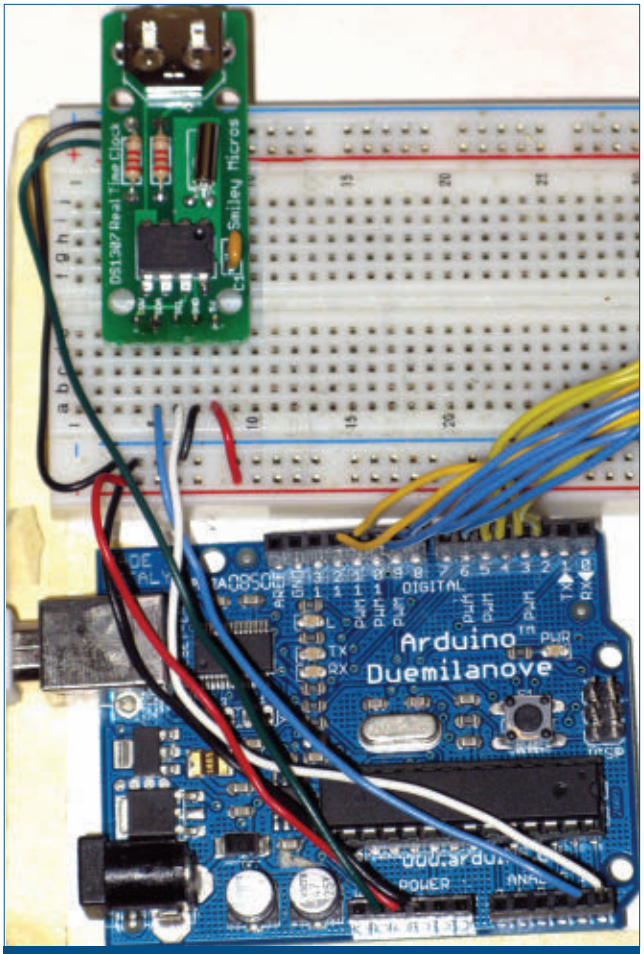
seconds in a minute — all 60 of them in five bits (stores up to 64 unique values). What you are seeing is BCD (Binary Coded Decimal) storage. This allows the binary numbers to be directly used to express human readable numbers without translating them. In a later Workshop, we will see how to use what we have learned about data structures to manipulate the DS1307 data in software. Since we are limited in space, let's build our real time clock now and learn about the code later.

Build a DS1307 Circuit on a Breadboard

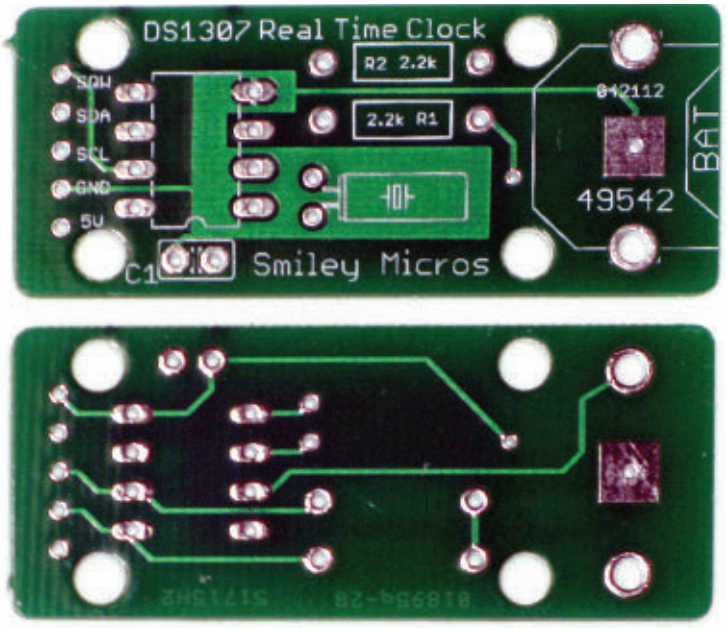
We see an illustration for a DS1307 circuit on a breadboard in **Figure 4**. This illustration was generated in Fritzing — a very interesting open source application that hopes to be for Electronic Computer Aide Design (ECAD) what the Arduino is for microcontrollers. We will get into the details of Fritzing next time, but for now let's build our real time clock and test it with an Arduino.

We see a close-up of the breadboard in **Figure 5** that has labels added to help us with our wiring. **Figure 6** shows how this looks on a real breadboard.

With those great images in **Figures 4** and **5,** you'd think I'd wire it up like that, but I didn't. I had wired it up and tested it before I came across Fritzing which I used to make **Figures 4** and **5**. Showing the alternate wiring doesn't cause any real problems. You can wire it up either way, as long as you make sure you



■ FIGURE 15. DS1307-RTC on breadboard with Arduino.



■ FIGURE 13. Arduino DS1307 printed circuit board.

■ FIGURE 14. DS1307 RTC PCB with components.

get the power and ground correct. **Figures 6** and **7** show the DS1307 wired up on a breadboard for use with the Arduino. It also has the LCDNAV wired up (perhaps for a breadboard alarm clock that we might see in a later Workshop).

Bill of Materials

Table 1 lists the parts you can get from **www.mouser.com**. (Or, as mentioned before, you can check the *Nuts & Volts* Webstore where you can get these parts and a PCB to mount them on.)

Using the DS1307 With the Arduino

There is an excellent library for the Arduino at **www.arduino.cc/playground/Code/Time** that lets you use a DS1307. Follow the Arduino directions for including a library. Then, click on the library and the DS1307 examples as shown in **Figure 8**. The files shown in **Figure 9** calculate the seconds from the Unix Epoch which began 1/1/1970, convert that to days and then to now (today's date/time) plus seven days and 30 seconds as shown in **Figure 10**.

DS1307-RTC Kit

There is certainly nothing wrong with purchasing all the parts and then building this circuit on a breadboard as discussed above. It is easier and more reliable, however, to build it on a printed circuit board. **Figure 11** shows the schematic; **Figure 12** shows the components. **Figure 13** shows the PCB; **Figure 14** shows the PCB with the parts mounted; and **Figure 15** shows it on a breadboard hooked up to an Arduino. The DS1307 uses the I²C bus where pin 6 goes to SDA and pin 7 goes to SCL. On the Arduino, we connect the SDA to the analog pin 4 and SCL to analog pin 5. These Arduino pins are, of course, not used in the analog mode, but are set up in software for the I²C bus. You can use the same software as discussed above for the breadboard version of the design.

So, now we have a tool to provide a real time clock on a breadboard. We see that we can use this tool with an open source Arduino library. My goal in building the breadboard RTC was to provide a design that can be

ported to a PCB break-out board for ease of use, and then use the data from this board to look in more detail at how C handles dates and times.

Along the way, I ran into Fritzing which gives us **Figures 4** and **5**. Fritzing is a free open source program that hopes to do for hardware design what the Arduino has done for software. Amazingly, they have somewhat succeeded.

Anyway, Fritzing is so compelling that I've decided to delay the C time discussion. So next time, we will begin a two-part series on Fritzing and then resume our C time discussion after that. **NV**

BitScope
Digital + Analog

Everything in one tiny package !

100 MHz Digital Oscilloscope
Dual Channel Digital Storage Oscilloscope with up to 12 bit analog sample resolution and high speed real-time waveform display.

40 MSPS x 8 Channel Logic Analyzer
Captures eight logic/timing signals together with sophisticated cross-triggers for precise multi-channel mixed signal measurements.

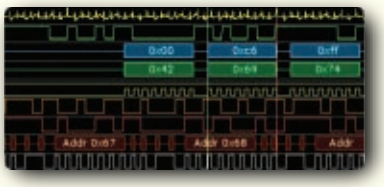
Serial Logic and Protocol Analyzer
Capture and analyze SPI, CAN, I2C, UART & logic timing concurrently with analog. Solve complex system control problems with ease.

Real-Time Spectrum Analyzer
Display analog waveforms and their spectra simultaneously in real-time. Baseband or RF signals with variable bandwidth control.

Waveform and Logic Generators
Generate an arbitrary waveform and capture analog & digital signals concurrently or create programmable logic and/or protocol patterns.

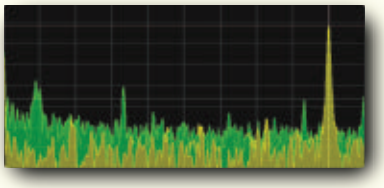
Multi-Channel Chart Recorder
Record to disk anything BitScope can capture. Allows off-line replay and waveform analysis. Export captured waveforms and logic signals.

Protocol Analyzer

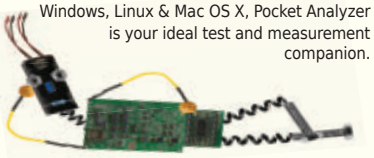


Digital Oscilloscope

Spectrum Analyzer



Compatible with major operating systems including Windows, Linux & Mac OS X, Pocket Analyzer is your ideal test and measurement companion.



bitscope.com/nv

USB-LOGIC
USB Logic Analyzer

CanaKit™
www.canakit.com

DSO-NANO-V2
Pocket-Sized Digital Oscilloscope

ARDUINO-STK
Arduino Uno Starter Kit

UK1104
4-Port USB Relay Controller with 6-Channel Analog/Digital Interface

FM Transmitters • Timers • Audio Amplifiers • Motor Controllers • Custom Designs

www.canakit.com 1•888•540-KITS (5487)

READER FEEDBACK

Continued from page 53

one has to navigate these days to get a ham license. The process is not well described and may be more complex than the technical exam to get the license. Whose job is it to make the method more well known and understood? Anyway, we appreciate you clearing this up.

Lou Frenzel W5LEF

Hmmmm ...

On page 10 of the June '12 issue, "Spotlight on Bacteria" claims the light goes through 25 m. (Was an "m" missing? Perhaps 25 mm ~ 1"? Otherwise, that would be 25 m or approx. 75 ft!)

Phil Karras KE3FL

Good catch, Phil! It should have been micrometers (µm.) Looks like the µ was dropped.

Unlocking Phones (Not!)

After reading Louis Frenzel's article, "What is 4G Wireless" — which was pretty helpful and timely since I'm researching smartphones to buy for the first time (I currently use a feature phone) — I have a question. Can unlocked phones from Europe and Asia be used just as well in the US? Especially re: Internet service? Would the Internet service be at high speeds (3G or 4G)?

I was told by a TMobile in-store sales rep (I subscribe to TMobile) that even if I get an unlocked phone intended for the markets in those continents, I wouldn't be able to use the Internet very well in the US, because Europe and Asia use different channels within the same bandwidth. Or something like that. I may not be using the right terminology. Conceptually, what I understood it as is the phones in Europe and Asia are within the same range of frequencies as the US for Internet, but within that range, the European and Asian phones use a different frequency than the US, so I wouldn't get any "reception," so to speak, for the Internet, or very little.

He said that Samsung specifically sets phones for TMobile at a certain channel so that they work within its network. I asked if those channels could be changed, and he said no, it would be very difficult; they're preset. What are your thoughts? Thank you for any feedback!

Christina Hur

The T-Mobile rep is right. The smartphones used in Europe and Asia use different bands and frequencies so generally do not work in the US. There is no way to change the frequency. They are fixed. In general, unlocking a phone is a nightmare. It causes more wasted time and grief unless you are a super guru hacker type. You will not save money this way. Bite the bullet and get a US phone.

Lou

A Matter of Degrees

This note was prompted by Ron Hackett's article "Interfacing the DS18B20 Digital Thermometer" and the necessary code decision needed to account for below zero temperatures (page 18 in the June '12 issue).

A clean way to convert degrees C to degrees F is: F = (C + 40) * 9 / 5 - 40. This way, no decision needs to be made in code for less than zero degrees.

To change from degrees F to degrees C, one need only exchange the 9 and 5: C = (F + 40) * 5 / 9 - 40.

The reason this works is because a graph of F and C temperatures cross at -40.

Sheridan George

Thank you for your suggestion for avoiding making a decision in code for less than zero degrees C.

I assume your formulas would work in a programming system that is able to handle negative numbers. However, the PICAXE BASIC compiler is limited to computations involving positive integers. In the example on page 18, if the temperature is -5 degrees C, PICAXE BASIC is not able to compute the value of (-5 + 40) in your formula; in fact, we can't even assign a value of -5 to a variable. As a result, it's necessary to do separate calculations in code for positive or negative values (adding or subtracting magnitudes accordingly), and then assign the appropriate sign ("+" or "-") to the result. I hope this clarifies the issue.

Ron

For complete product details, visit our webstore!!

The Nuts & Volts WEBSTORE

GREAT FOR DIYers!

Steampunk Gear, Gadgets, and Gizmos
by Thomas Willeford

A Maker's Guide to Creating Modern Artifacts

Welcome to the wondrous world of Thomas Willeford (a.k.a., Lord Archibald "Feathers" Featherstone) in which he shares his closely guarded secrets of Steampunkery. Filled with do-it-yourself projects, *Steampunk Gear, Gadgets, and Gizmos: A Maker's Guide to Creating Modern Artifacts* shows you how to build exquisite, ingenious contraptions on a budget.

$24.95

How to Diagnose and Fix Everything Electronic
by Michael Jay Geier

Master the Art of Electronics Repair!

In this hands-on guide, a lifelong electronics repair guru shares his tested techniques and invaluable insights. *How to Diagnose and Fix Everything Electronic* shows you how to repair and extend the life of all kinds of solid-state devices, from modern digital gadgetry to cherished analog products of yesteryear. **About the Author:** Michael Jay Geier began operating a neighborhood electronics repair service at age eight that was profiled in *The Miami News*.

$24.95

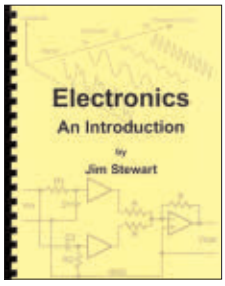
Programming Arduino Getting Started with Sketches
by Simon Monk

Program Arduino with ease!

Using clear, easy-to-follow examples, *Programming Arduino: Getting Started with Sketches* reveals the software side of Arduino and explains how to write well-crafted sketches using the modified C language of Arduino. No prior programming experience is required! The downloadable sample programs featured in the book can be used as-is or modified to suit your purposes.

$14.95

Electronics An Introduction
by Jim Stewart

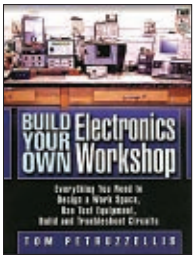


This book is designed as an in-depth introduction to important concepts in electronics. While electronics can be highly mathematical, this text is not about calculations. It is about how electronic equipment is able to extract, process, and present information held in electrical signals. If you are in — or studying to be in — a profession that requires the use of electronic equipment, then this book will provide the insight necessary to use such equipment effectively.

$33.95*

Build Your Own Electronics Workshop
by Thomas Petruzzellis

BUILD YOUR OWN DREAM ELECTRONICS LAB!



This value-packed resource provides everything needed to put together a fully functioning home electronics workshop! From finding space to stocking it with components to putting the shop into action — building, testing, and troubleshooting systems. This great book has it all! And the best part is, it shows you how to build many pieces of equipment yourself and save money, big time!

Reg Price $29.95
Sale Price $26.95

Beginner's Guide to ... Programming the PIC24/dsPIC33
by Thomas Kibalo

Kibalo takes you step by step through the fundamentals of programming the PIC24H which can equally be applied to the dsPIC33. His clear explanation of the inner workings make learning the PIC24H/dsPIC33 16-bit architecture easy. His code examples demonstrate how to perform the functions most applications require. The hardware is shown in a simple breadboard setup so even a beginner can build it, along with very few extra components needed.

$39.95*

HTML: A Beginner's Guide
by Wendy Willard

Create highly functional, impressive websites in no time. Fully updated and revised, *HTML: A Beginner's Guide*, Fourth Edition explains how to structure a page, place images, format text, create links, add color, work with multimedia, and use forms. You'll also go beyond the basics and learn how to save your own web graphics, use Cascading Style Sheets (CSS), create dynamic web content with basic JavaScript, and upload your site to the web. By the end of the book, you'll be able to build custom websites using the latest HTML techniques.

$29.95

Programming PICs in Basic
by Chuck Hellebuyck

If you wanted to learn how to program microcontrollers, then you've found the right book! Microchip PIC microcontrollers are being designed into electronics throughout the world and none is more popular than the eight-pin version. Now the home hobbyist can create projects with these little microcontrollers using a low cost development tool called the CHIPAXE system and the Basic software language. Chuck Hellebuyck introduces how to use this development setup to build useful projects with an eight-pin PIC12F683 microcontroller. **$14.95**

Master and Command C for PIC MCUs
by Fred Eady

Master and Command C for PIC MCU, Volume 1 aims to help readers get the most out of the Custom Computer Services C compiler for PIC microcontrollers. The author describes some basic compiler operations that will help programmers particularly those new to the craft create solid code that lends itself to easy debugging and testing. As Eady notes in his preface, a single built-in CCS compiler call (output_bit) can serve as a basic aid to let programmers know about the "health" of their PIC code.

$14.95

Order online @ **www.store.nutsvolts.com**
Or CALL **1-800-783-4624** today!

BOOK & KIT COMBOS

Proto Buddy Book & Kit Combo

For complete details visit our webstore @ www.nutsvolts.com

Beginner's Guide Vol 3 Combo

For complete details, visit our webstore @ www.servomagazine.com.

An Arduino Workshop
Book: An Arduino Workshop $44.95
Projects Kit $84.95
Book and Kit Combo $124.95
C Programming for Microcontrollers
Book: C Programming for Microcontrollers $44.95
Projects Kit $58.49
Book and Kit Combo $99.95

DS1307 Real Time Clock Kit

Parts Kit for this Month's Smiley's Workshop
DS1307-RTC Real Time Clock Kit with Battery
$14.95

Breadboardable LCD Navigator

Breadboard friendly LCD and five-button keypad parts kit. Details on Smiley's Blog at: www.smileymicros.com\blog.

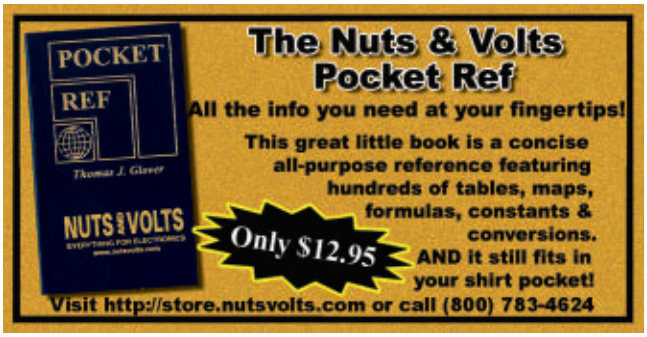
$34.95

From Smiley's Workshop

CD-ROM SPECIAL

Nuts & Volts 8 CD-ROMs & Hat Special!
That's 96 issues. Complete with supporting code and media files.

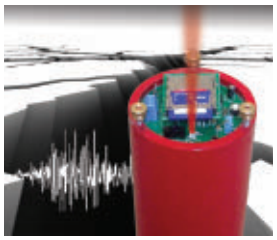
Only $169.95
or $24.95 each.


POCKET REF
Thomas J. Glover
NUTS & VOLTS
The Nuts & Volts Pocket Ref
All the info you need at your fingertips!
This great little book is a concise all-purpose reference featuring hundreds of tables, maps, formulas, constants & conversions.
AND it still fits in your shirt pocket!
Only $12.95
Visit http://store.nutsvolts.com or call (800) 783-4624

CALL 1-800-783-4624 today!
Order online @ www.nutsvolts.com

PROJECTS

Seismograph Kit

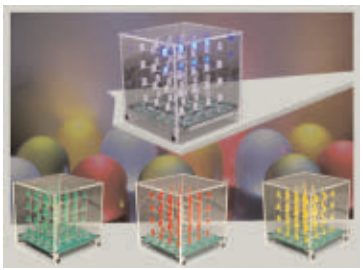


As seen in the May 2012 issue. Now you can record your own shaking, rattling, and rolling.

The Poor Man's Seismograph is a great project /device to record any movement in an area where you normally shouldn't have any. The kit includes everything needed to build the seismograph. All you need is your PC, SD card, and to download the free software to view the seismic event graph.

Subscriber's Price **$79.95**
Non-Subscriber's Price **$84.95**

3D LED Cube Kit



This kit shows you how to build a really cool 3D cube with a 4 x 4 x 4 monochromatic LED matrix which has a total of 64 LEDs. The preprogrammed microcontroller that includes 29 patterns that will automatically play with a runtime of approximately 6-1/2 minutes.
Colors available: Green, Red, Yellow & Blue

Subscriber's Price **$57.95**
Non-Subscriber's Price **$59.95**

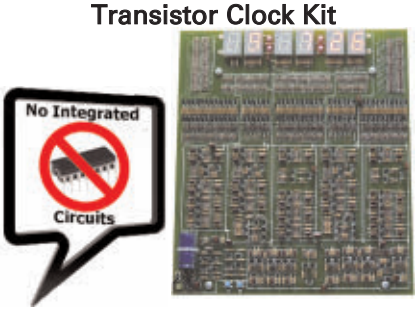
Battery Marvel Kit

As seen in the November 2011 issue. Battery Marvel helps protect cars, trucks, motorcycles, boats, and any other 12V vehicles from sudden battery failure. This easy-to-build kit features a single LED that glows green, yellow, or red, indicating battery health at a glance. An extra-loud piezo driver alerts you to any problems.

For more info, please visit our website.

Subscriber's Price **$18.95**
Non-Subscriber's Price **$19.95**

Transistor Clock Kit

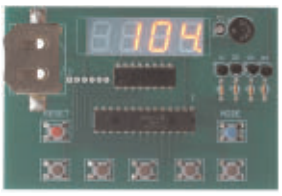


If you like electronic puzzles, then this kit is for you! There are no integrated circuits; all functionality is achieved using discrete transistor-diode logic. The PCB is 10"x11" and harbors more than 1,250 components! For more info, see the November 2009 issue.

Reg $225.95
Sale Price $199.95
PCBs can be bought separately.

Sorting Counter Kit

As seen in the July 2011 issue.

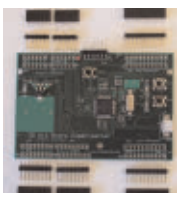


Sorting counters have many uses — keeping score, counting parts, counting people — it is just a handy gadget to have around. This is a very simple project for those who want to learn to solder or are interested in using microprocessors and how they function. No special tools are needed, just a small tip soldering iron. It has no box as it stands alone, therefore there is no drilling.

Subscriber's Price **$33.95**
Non-Subscriber's Price **$39.95**

32-Bit Micro Experimenter Board

The 32-Bit Micro Experimenter is the fastest way to learn 32-bit microcontrollers.

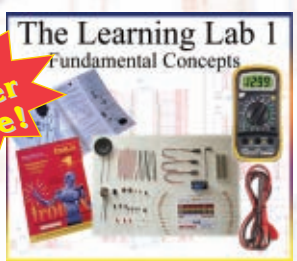


The kit includes onboard 46 programmable I/O and USB, free software, carefully documented step-by-step experiments for USB, embedded web server, graphics and audio, wireless, RTOS, and file I/O. User pushbuttons, LEDs, and 32 kHz clock crystal. Can be used in solderless breadboard environment or stand-alone.

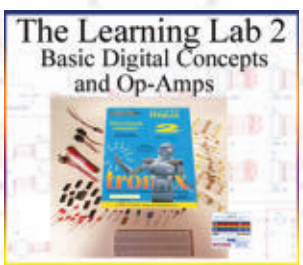
Subscriber's Price **$89.95**
Non-Subscriber's Price **$93.95**

FOR BEGINNER GEEKS!

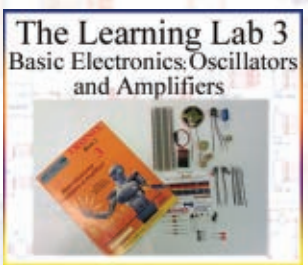
New Lower Price!



$59.95



$49.95



$39.95

The labs in this series — from GSS Tech Ed — show simple and interesting experiments and lessons, all done on a solderless circuit board. As you do each experiment, you learn how basic components work in a circuit, and continue to build your arsenal of knowledge with each successive experiment.

For more info and a promotional video, please visit our webstore.

ELECTRONET

GET THE NUTS AND VOLTS DISCOUNT!
Mention or enter coupon code NVRMZ12 and receive 10% off your order!
ramsey
www.ramseykits.com
AM/FM Broadcasters • Hobby Kits
Learnng Kits Test Equipment
...AND LOTS OF NEAT STUFF!

www.canakit.com
• Over 200 Kits & Modules to choose from!
• Easy Worldwide Online Ordering
• Fast Delivery & Same Day Shipping
FM Transmitters • Timers • Audio Amplifiers • Motor Controllers

THE ORIGINAL SINCE 1994
PCB-POOL
Beta LAYOUT
• Low Cost PCB prototypes
• Free laser SMT stencil with all Proto orders
WWW.PCB-POOL.COM

USB
Add USB to your next project-- It's easier than you might think!
DLP Design
USB-FIFO • USB-UART • USB/Microcontroller Boards
RFID Readers • Design/Manufacturing Services Available
Absolutely NO driver software development required!
www.dlpdesign.com

INVEST in your BOT!
INVEST in HITEC
12115 Paine Street • Poway, CA 92064 • 858-748-6948 • www.hitecrcd.com

superbrightleds.com
Component LEDs - LED Replacement Bulbs - LED Accent Lighting
Super Bright LEDs Inc. St. Louis, Missouri - USA superbrightleds.com

Chip Adapters
10% Off Adapters with Coupon Code: NVEZ1012
www.EZPrototypes.com

Serial LCD & LED
www.melabs.com

Pololu
Robotics & Electronics
WWW.POLOLU.COM

An Arduino Workshop
Book: An Arduino Workshop $44.95
Projects Kit $84.95
Book and Kit Combo $124.95
C Programming for Microcontrollers
Book: C Programming for Microcontrollers $44.95
Projects Kit $58.49
Book and Kit Combo $99.95
DS1307 Real Time Clock Kit
Parts Kit for this Month's Smiley's Workshop
DS1307-RTC Real Time Clock Kit with Battery
$14.95
Call to order at 1-800-783-4624
or go to www.nutsvolts.com

Proto Buddy Book & Kit Combo
DO-IT-YOURSELF Circuitbuilding FOR DUMMIES
Includes an article reprint!
Only $59.95
For complete details visit our webstore @ www.nutsvolts.com

For the ElectroNet online, go to www.nutsvolts.com click Electro-Net

ALL ELECTRONICS CORPORATION
Electronic Parts & Supplies Since 1967

■ BY L. PAUL VERHAGE

Discuss this article in the *Nuts & Volts* forums at http://forum.nutsvolts.com.

A NEW BALLOONSAT AIRFRAME DESIGN

When teaching students to make BalloonSats, I give them six sheets of Styrofoam and ask them to cut and glue them together to form a hollow box. During their construction, students also must cut channels for tubing and determine where to mount the electronics and sensors. However, if you look at a CubeSat, you'll notice that they are assembled by stacking planes. So I asked myself, why not attempt something like that for BalloonSats?

■ **FIGURE 1.** University of Kansas AE360 class BalloonSats on their way to near space.

Since starting my dissertation on the effects of BalloonSats on student attitude toward science, I've been giving some thought to the design of the BalloonSat airframe. This is partly because I already have a good BalloonSat flight computer design and would like an airframe design to match. Somehow, just giving students six sheets of Styrofoam and asking them to make an airframe seems crude and undeveloped in comparison.

For readers not familiar with CubeSats, they are small satellites that follow a simple design standard. CubeSats are 10 centimeter cubes containing a flight computer, sensors, batteries, and solar cells. All the components are stacked together like the shields of an Arduino. Then, solar panels are clipped to the outside faces of the stack. Many universities have purchased a kit for their aerospace students to build. After students have finished their CubeSat, it can be launched into earth orbit.

So, why not try something similar for BalloonSats? Now, I'm not claiming to have the perfect solution to BalloonSat design, but I did test the following design and I am very happy with the results. Therefore, this month let me share the design and let's see how far it can evolve.

CELLFOAM 88 AND PLASTIC TUBES

The traditional Styrofoam used in the construction of

BalloonSat airframes has a soft face; you can easily mar the surface. I therefore opted to use Cellfoam 88 for the airframe material. Cellfoam 88 is traditional Styrofoam, but the faces of it are pressed between two hot rollers. This gives the face a hard and smooth surface. This hardness and smoothness of Cellfoam 88 is somewhere between a soft Styrofoam and a solid sheet of polystyrene.

I discovered this allows you to glue a solid sheet of Styrene to the face of Cellfoam 88 (if liquid polystyrene glue is used). If, on the other hand, you try gluing Styrene to traditional foam, the glue will melt the foam.

A weather balloon will carry many BalloonSats into near space by attaching them together with one or more cords. BalloonSats must have some type of tube through the airframe. The tube forms a channel for the cords that protects the Styrofoam airframe from abrasion. In my traditional (that is, until now) airframe, students cut channels into the walls of the airframe and glued the tubes into them. That way, the tube does not reduce the useable volume of the airframe.

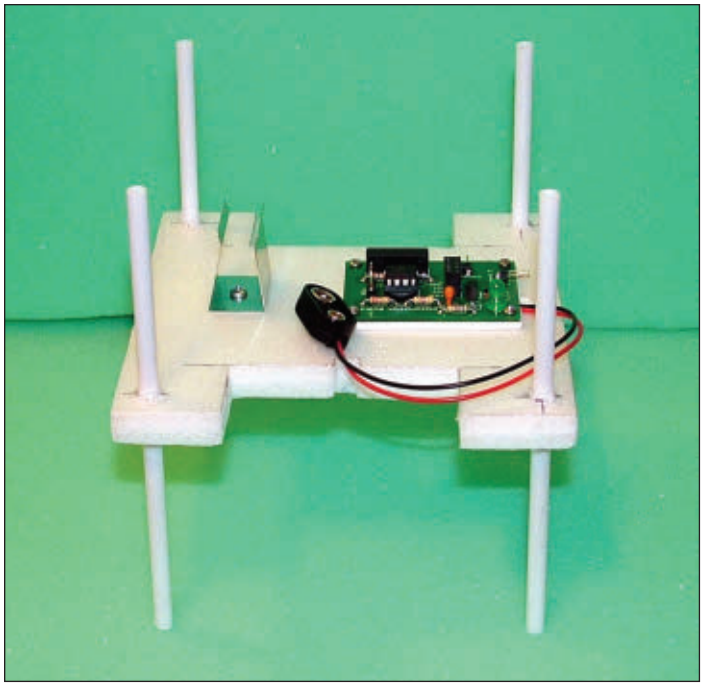
So, Cellfoam 88 and plastic tubes are the core of the airframe design in this article. To replicate the CubeSat concept, I stacked layers of uniformly cut Cellfoam 88 sheets on four plastic tubes. These form decks that slide up and down the four tubes. The holes for the tubes are drilled near the corners of the decks where they create the least impact to useable volume. Since the BalloonSat is a small cube, the number of decks in very limited.

I settled for three in my first test: a top, bottom, and middle deck. This created two bays: an upper and a lower. I placed the camera in the lower bay and the electronics and battery in the upper bay.

CONSTRUCTING THE AIRFRAME

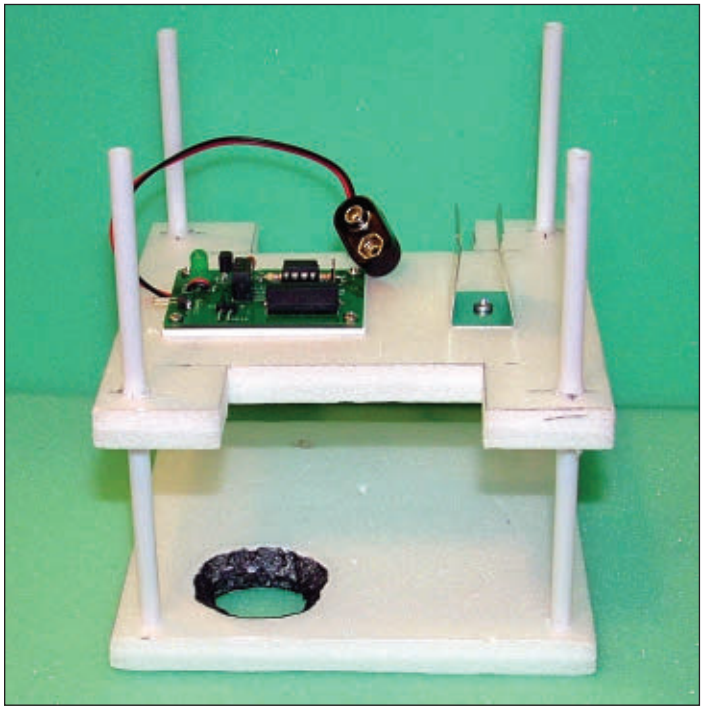
I began cutting out four sheets of Cellfoam 88. I used the 10 mm thick sheets and cut them into squares measuring five inches on a side. The design only needed three sheets, but I cut an additional sheet as a backup. I then stacked the sheets and drilled four holes near their corners. The holes were 3/16 inches in diameter — just large enough for the plastic tubes. By drilling the sheets while they were stacked together, the tubes passed through the same positions on all four decks.

Bolting stuff to Cellfoam requires care because a tight nut and bolt will crush the foam. Therefore, I glued a thin sheet of polystyrene plastic to the underside of the Styrofoam. I mounted the electronics to the top of the Styrofoam with a foamed neoprene sheet beneath it. Neoprene foam is available in colorful sheets at many craft stores where it is sold under names like Fun Foam, Funky Foam, and Foamies. Finally, I used a nylock (nylon insert nut) in place of a hex nut. Using a plastic sheet, slightly compressed neoprene foam, and nylocks seems to be a very secure way to attach the electronics to Styrofoam.

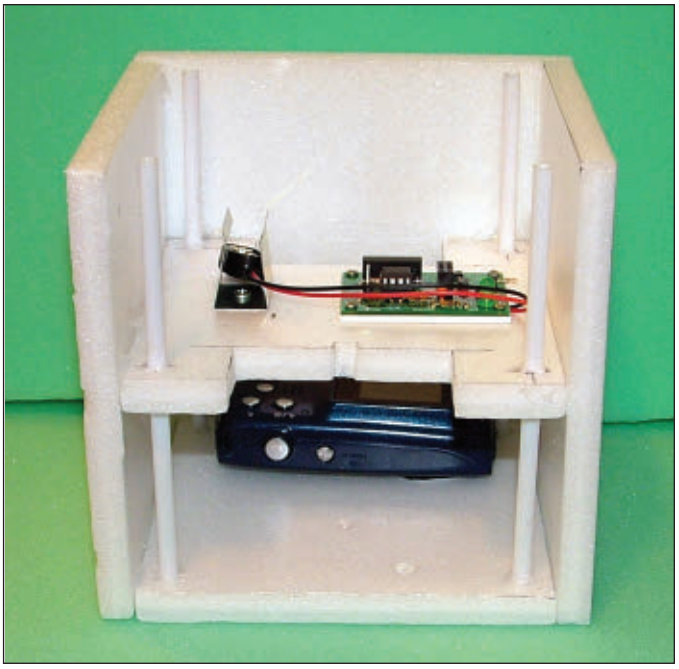


■ **FIGURE 2.** In the initial test-fitting, I bolted the flight computer to the middle deck and mounted the middle deck on the four corner tubes. At this point of the construction, the middle deck was glued to the tubes. The middle deck would divide the BalloonSat into two equally tall bays.

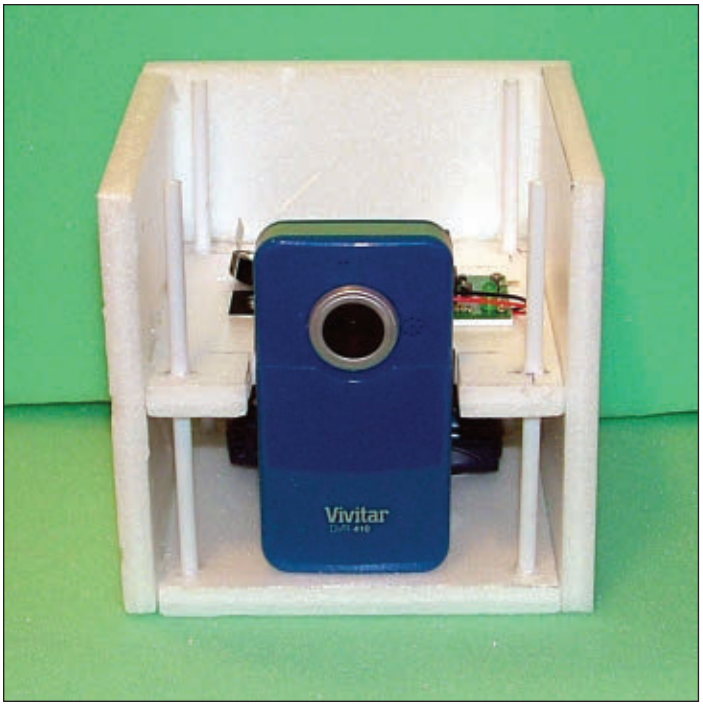
As you can see in **Figure 2**, there are two notches cut into the middle deck. I initially cut them so I could route



■ **FIGURE 3.** Next up, test-fitting the bottom deck of the airframe. This is where the digital camera will reside. I cut a hole in the Styrofoam for the camera lens and darkened it with a permanent black marker.

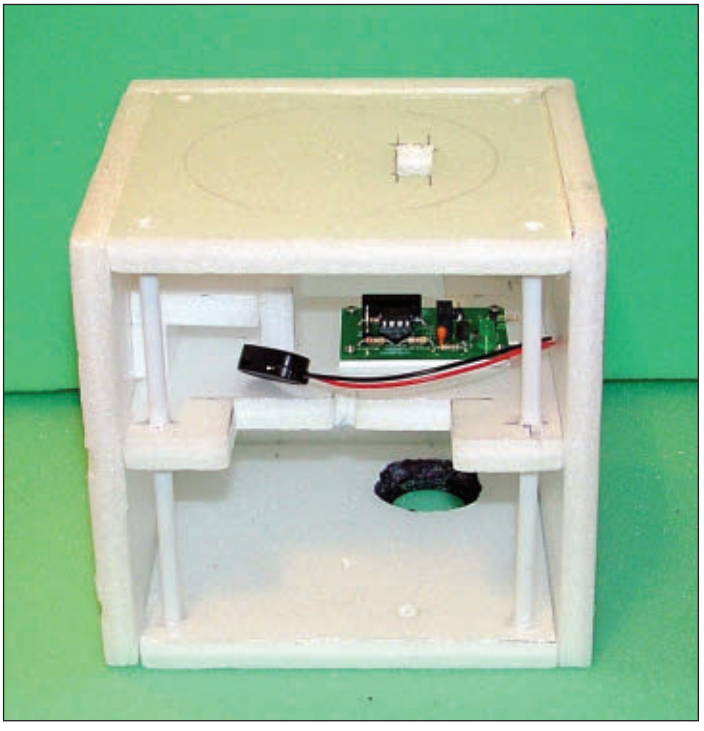


■ **FIGURE 4.** At this point, the sides have been glued to the bottom and middle decks.



■ **FIGURE 5.** Test-fit of the video camera.

wires between the upper and lower bays. Later, I decided to attach a small digital video recorder to one face of the BalloonSat. However, I didn't know which face at the time as the design could support a hatch on one face or on two opposite faces. Therefore, I cut both notches large enough for the camera. That let me put off deciding which face gets the video camera until later.



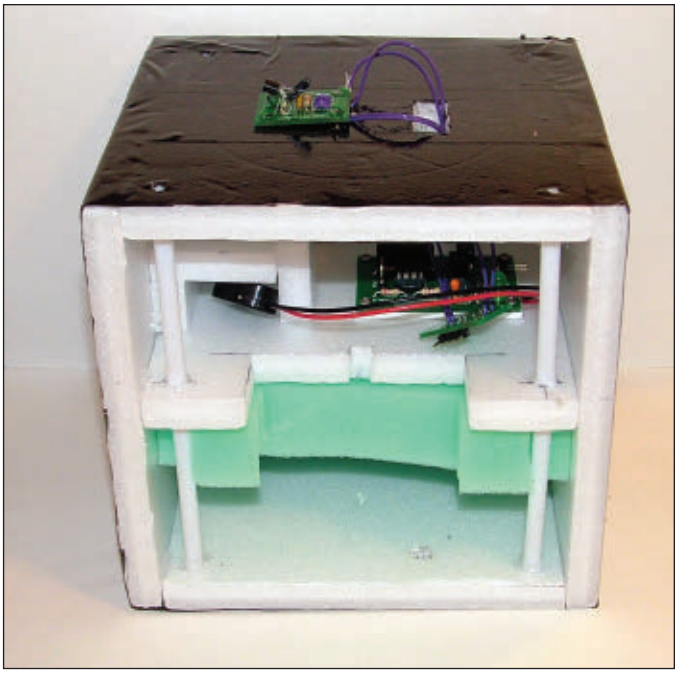
■ **FIGURE 7.** The airframe now has a top. The four holes drilled for the tubes are now visible. They are near the corners of the top deck.

I then stacked the middle deck and tubes on the bottom deck of the airframe. The digital camera looks out the bottom of the BalloonSat and so has to be mounted into the lower bay. Like most cameras, this one is designed to be mounted to a tripod using a 1/4-20 bolt. I placed the camera on the bottom deck so its base would be up against the future wall of the airframe. Then, knowing where the camera will lay, I cut out a hole in the bottom deck for the camera's lens. To prevent sunlight from causing glare, I then blackened the edges of the camera lens hole.

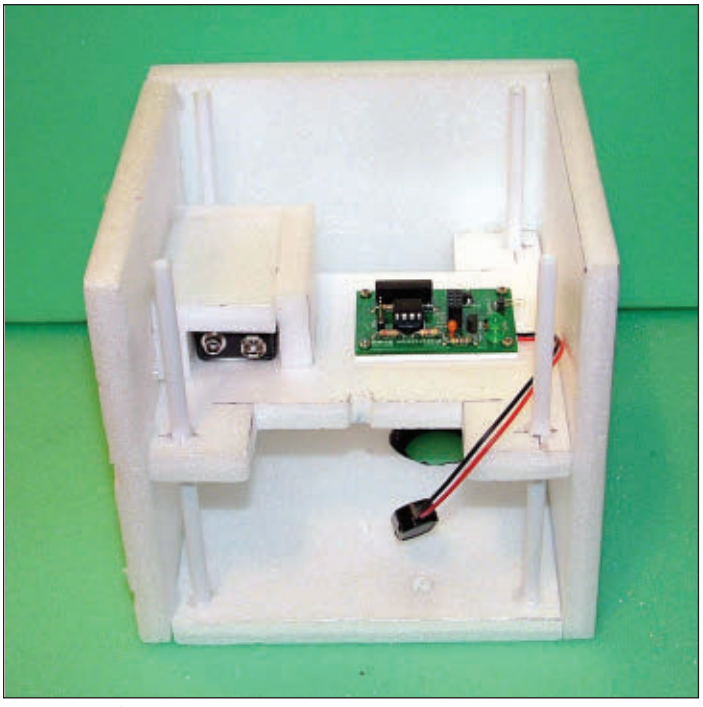
Next, I used hot glue to attach three of the airframe sides to the decks. I only attached three, since the fourth side will be the hatch of the BalloonSat. The camera was checked one more time to make sure that it still slid into the lower bay. I also measured the location for the camera's 1/4-20 threaded hole. Before drilling the 1/4 inch hole, I first drilled a small test hole in the airframe to double-check that my placement was accurate. After verifying the hole was properly placed, I finished drilling the larger hole for the bolt.

Before gluing the top to the airframe, I test-fitted the video camera. As you can see in **Figure 5**, it fits into the airframe and looks out the hatch. It was also at this point that testing showed that trying to snap the 9V battery into the holder would be a bad idea.

The stress and strain created by snapping the battery into the metal holder would eventually break the Cellfoam 88 of the middle deck. Therefore, I replaced the metal battery clip with a Styrofoam box made with 10 millimeter



■ **FIGURE 8.** The airframe has been wrapped in black tape. The holes in the tape are cut with an Exacto knife. However, I find that a hot soldering iron or hot Styrofoam knife is better for melting clean, small holes in the tape. The sensor array is hot-glued to the top of the airframe.



■ **FIGURE 6.** The battery box. By sliding the battery into this opened box, it's kept from bouncing all around inside the airframe.

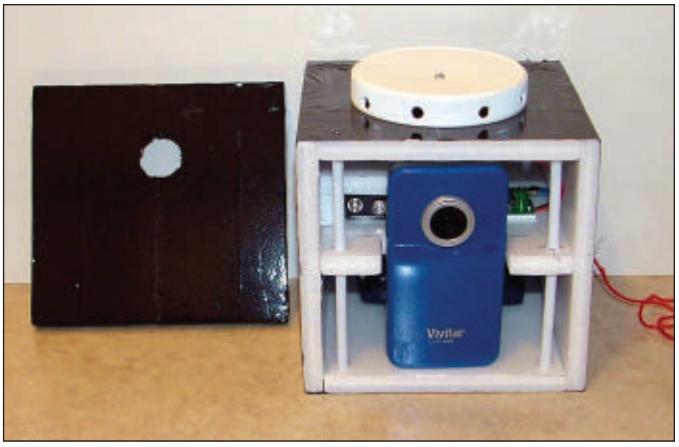
thick foam. The battery box was placed far enough from the front that it wouldn't interfere with attaching the video camera.

As you might begin to see, in this BalloonSat design I will connect the flight computer to the nine volt battery and then turn on the digital camera. Afterwards, I can start up the camcorder and close the hatch.

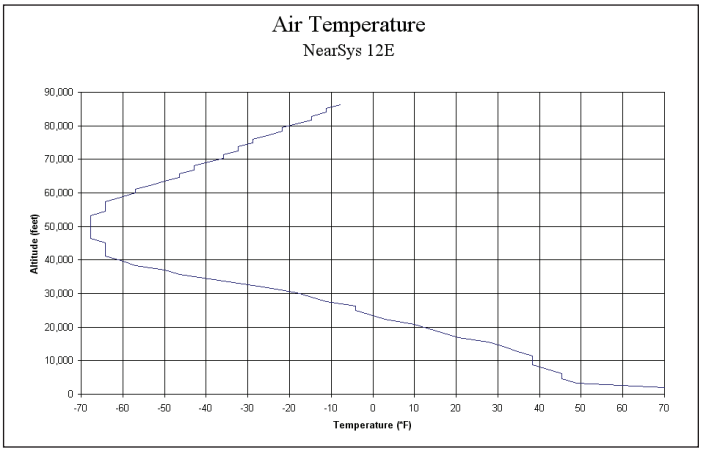
Now, it was time to attach the top deck. The weather sensors would be placed on the top, where their orientation (with respect to the sun) doesn't change significantly. If they are attached to the side of the airframe, the balloon's rotation would carry them in and out of the sun — perhaps affect their readings. The sensors I selected were an LM335 temperature sensor and a Honeywell HIH-4000 relative humidity sensor. Since both react to sunlight shining on them, I placed a white plastic lid over the sensors. The lid's rim was drilled with a series of holes that are designed to let the air flow in. However, the holes are small enough that no significant amount of sunlight can shine on the sensors inside. After gluing the top to the airframe, I marked the location of the plastic lid and cut a slot to allow the sensor's cable to pass into the airframe.

The results of a near space experiment that I performed years ago led me to believe that the interior of a BalloonSat airframe remains warmer if its exterior is colored black. Since the airframe material is Styrofoam, I use colored packing tape to add color to the BalloonSat. This tape is popular for covering Styrofoam gliders (in place of painting them). The tape is also used to seal and label packages in preparation for mailing. You can find it at Uline (**www.uline.com**) as item S-700. Another benefit of using the tape is that by wrapping it around the outside of the airframe, it creates compression that helps hold it together.

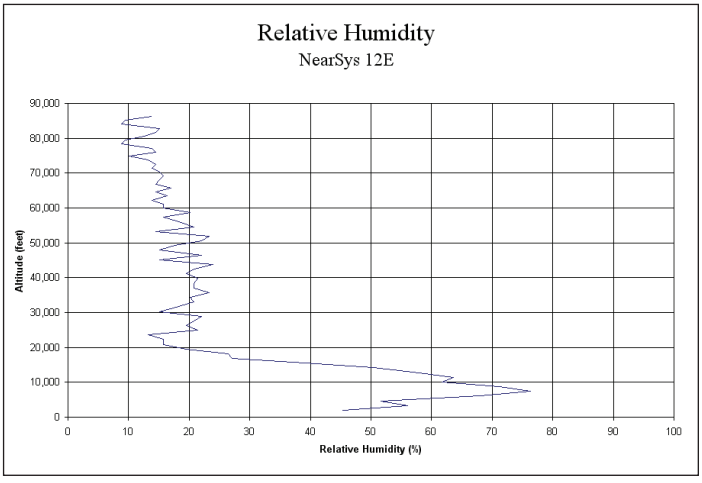
■ **FIGURE 9.** Everything but the hatch is ready. The cameras are bolted into the airframe as is the white plastic lid on top.



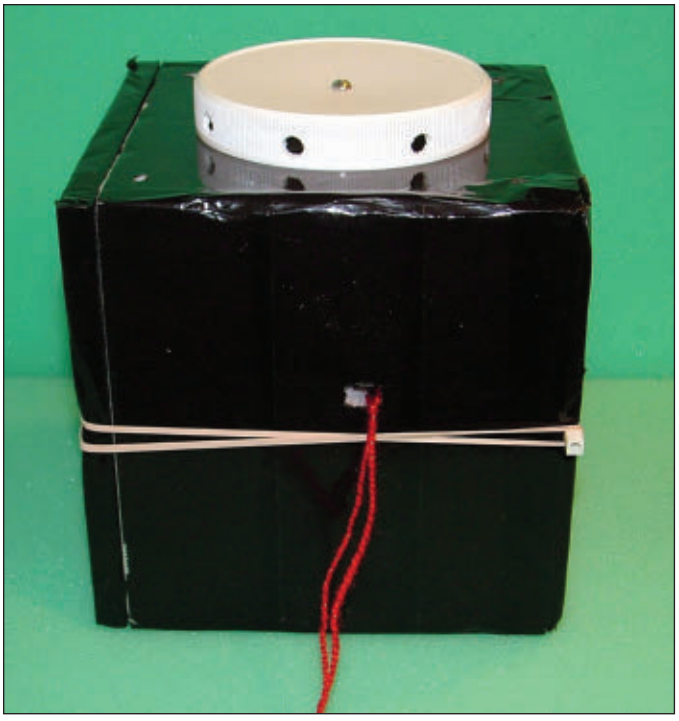
■ **FIGURE 11.** The red string on the right side of the BalloonSat is the flight computer's commit pin. It permits me to connect the battery to the flight computer ahead of time, but won't let it begin recording data. That is, until I pull out the pin.



■ **FIGURE 13.** The air temperature as a function of altitude. The increasing temperature above 50,000 feet indicates that this is the altitude where the stratosphere begins.



■ **FIGURE 14.** You can see we passed through a cloud layer at about 8,000 feet. The rest of the flight is very dry.

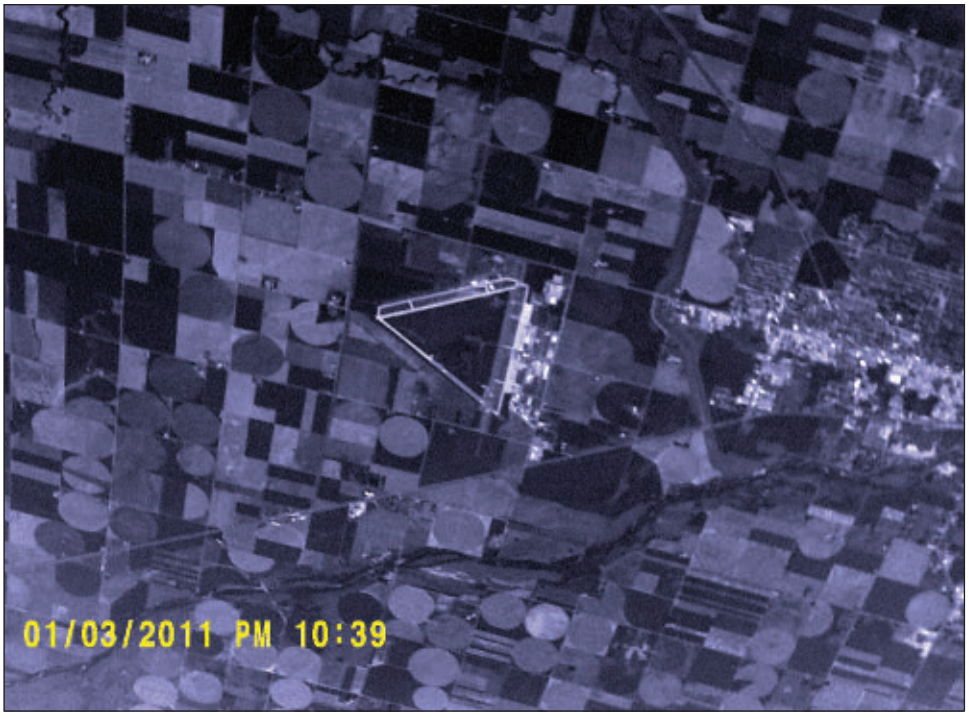


■ **FIGURE 12.** A side view of the BalloonSat airframe. The hatch is on the left side. You can see there's a small opening in the airframe for the commit pin cable to hang out of.

The downward-looking camera only bolts to the airframe at one point. This turned out to be a problem, since I left clear space around the camera so it could easily slide in and out of the lower bay. Without a tighter fit, the camera is liable to twist against the airframe during the chaotic descent and crack the foam airframe. Just in case, I took up the slack and added gentle pressure to the camera by sliding a sheet of thick foam latex to the top of the bottom bay.

The next step was the construction of the BalloonSat hatch. The hatch is a 10 millimeter thick sheet of Cellfoam 88 that sits on the surface of the opened airframe. However, I wanted to keep the hatch from sliding around. So, I cut rectangles out of five millimeter thick Cellfoam 88 that fit between the decks of the BalloonSat. These were then strategically hot-glued to the inside of the hatch. Now, the hatch snaps into place on the airframe, but the rectangles keep it from twisting or sliding around. The position of the video camera's lens was measured and I cut a hole in the hatch to match. Finally, the hatch was given a coat of black tape.

I made one change to the airframe after its assembly. I wanted a simple way to hold the hatch closed, so I cut a channel in the back of the airframe and glued a square tube into it. The tube was about seven inches long, so it extends a 1/2 inch beyond both sides of the airframe. That square tube stands out like a sore thumb in the back of the airframe, therefore, I covered the construction site over with a strip of black sealing tape. To lock the hatch, I



■ **FIGURE 15.** This is Great Bend and its airport as seen from 59,000 feet. I had been experimenting with using this camera for near infrared photography and forgot to change its settings back to color.

wrap a rubber band around one end of the tube, across the hatch, and then wrap it around the other end of the tube.

SUCCESS, MOSTLY

I had a chance to fly my new BalloonSat on April 22, 2012. The launch took place at the Physics department of Ft. Hays State University (thanks Dr. Adams and Dr. Maseburg). My BalloonSat was tracked using the Ft. Hays APRS tracker and one of mine.
I was glad for the Ft. Hays tracker, as I was recently having trouble with my trackers quitting during flight. (The problem was eventually traced to old batteries, but I digress.) The flight reached just under 87,000 feet and landed south of Great Bend, KS. I recorded the information in **Figures 13**, **14**, and **15** concerning the air temperature and relative humidity with this BalloonSat.

LESSONS LEARNED

The BalloonSat worked well, overall. However, I learned several things on this mission. First, check the size of the SD memory card in the video camera and make sure it can record an entire mission (over two hours). I also discovered that if the BalloonSat gets shaken too much, the camera's power button and SD memory card can bang into the Styrofoam airframe. Pushing on the camera's power button will shut it off and pushing the SD memory card will eject it from the camera.

That's a pity because there's no one onboard to restart the recording or reinsert the camera's SD card. So, I've now learned to cut small notches into the Styrofoam where it could make dangerous contact with the camera. I later discovered that depending on the camera, a small nylon bolt can be inserted into the AV jack to push the camera power switch away from the Styrofoam airframe. Finally, if you or someone else messes around with a camera, be sure to reset it when you're done.

Onwards and Upwards,
Your near space guide **NV**
(Making mistakes so you don't have to)

Did you know that if you're a paid subscriber to *Nuts & Volts*, you can get the online version for *FREE?*
Go to **www.nutsvolts.com** *for details.*

Teachers! Do you agree? Students with a good hands-on foundation in Electronics are more successful!

Then our Tron.ix 1 Lab is where to start.
Order Today,
Scan the QR-Code

www.GSSTechEd.com
800-422-1100
Be Worth More . . . Learn Electronics!

Continued from page 29

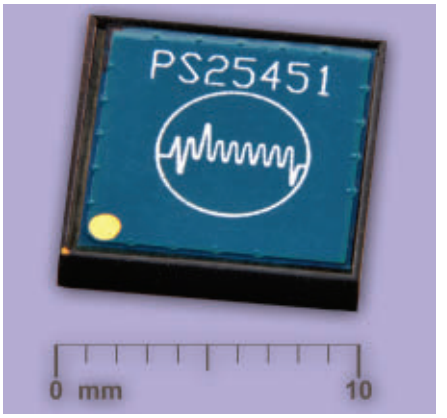
focus on finding problems by monitoring real time readings on a laptop or computer screen from safe distances — up to 30 feet away.

The meter comes complete with a remote USB receiver, Windows® compatible software, test leads with alligator clips, Type K bead wire temperature probe with adapter, carrying case, and six AA batteries. The MG300 is available with NIST-traceable certification (model MG300-NIST). For users outside North America, the MG302 which transmits data at 433 MHz instead of 915 MHz is also available.

For more information, contact:
Extech
Web: **www.extech.com**

LOW COST EPIC SENSOR FOR REMOTE CONSUMER APPS

Saelig Co., Inc., announces the PS25451 — an ultra-low cost version of Plessey's award winning EPIC sensor that provides remote sensing for high volume consumer markets. The PS25451's economical



electrode design eliminates the more expensive titanium dioxide electrodes. The EPIC sensor (Electric Potential Integrated Circuit) measures electric field changes without physical or resistive contact. EPIC is an award winning, patent-protected technology for rapidly measuring spatial electric fields.

The PS25451 is an ultra-high impedance, non-contact, solid-state electric potential sensor that is suited for a variety of consumer devices such as proximity switching of lighting, gesture-based remote control of interactive toys, computer games, TVs, monitors, other appliances, and presence detection (even through walls) for security/alarm systems. The EPIC sensor works by measuring tiny changes in an electric field in a similar way to a magnetometer detecting changes in a magnetic field. This enables it to be used for security motion sensors and non-contact electrical switches, as well as medical applications detecting heart beats, nerve, and muscle activity either by dry contact (i.e., no gels required) or contactless.

The PS25451 is housed in a proprietary 3D package with exposed pins for surface-mount assembly, and measures 10 mm x 10 mm x 2 mm. By adjusting the gain and bandwidth of the associated amplification circuitry, the sensors can be tuned for detection at a distance as required.

EPIC technology functions at normal room temperatures as an ultra-high input impedance sensor that forms a highly stable, extremely sensitive, contactless digital voltmeter to measure millivolt electric field changes.

For more information, contact:
Saelig
Web: **www.saelig.com**

RADIOTRONIX PRODUCT LINES

Linx Technologies has started shipping the product lines it

ELECTRONIX EXPRESS

Visit Our Website At http://www.elexp.com

RSR 3MHZ SWEEP FUNCTION GENERATORS
6 Waveform Functions, Int/Ext Counter, lin/log sweep
MODEL FG-30 (No Digital Display) $135.00
MODEL FG-32 (5 Digit Display) $195.00

INSTEK CORP. OSCILLOSCOPE
MODEL GOS-620
Dual Channel – 20MHZ
(INCLUDES PROBES)
$305.00

DC POWER SUPPLIES
MODEL HY3003 – DIGITAL DISPLAY
Variable output, 0-30 VDC, 0-3 Amp $95.00
MODEL HY3003-3 – TRIPLE OUTPUT
Two 0-30 VDC, 0-3 Amp variable outputs plus 5V 3A fixed. Digital Display. $184.00

Weller® SOLDERING STATION
#1 BEST SELLING STATION
MODEL WLC 100
0603WLC100
$39.99

ROTARY TOOL KIT $35.95
Variable speed tool (37,000 RPM) with accessory kit in a hard plastic carry case.
#29DR101

BENCH DMM WITH RS232 INTERFACE
MODEL DM9803R
True RMS, digital and bar graph display, AC/DC Cap, Res, frequency functions. Includes software, AC or DC operation.
$139.95

DIGITAL MULTIMETER
32 Ranges – 3 1/2 Digit
MODEL MY-64 $33.95
AC/DC Volt/Current, Res. Cap., Frequency. Rubber Holster Included

ALLIGATOR LEADS
SET OF 10 $3.50

RSR HIGH PERFORMANCE 3-WIRE IRON
#060509
$6.50

SOUND SENSOR CAR
REQUIRES SOLDERING
Reverses direction whenever it detects noise, or touches an obstacle.
$9.95
#3221881

RSR DIGITAL MULTIMETER $6.50 10+
SUPER ECONOMY
MODEL 820B
1-9 ..... $7.50
#01DM820B

MORE Low-Priced Items In Our FREE 350+ Page Catalog

SWITCHES

	1-9	10+
8 POS DIP (V17DIP8SS)	.90	.85
Toggle Mini SPDT (17TOGSD-M)	1.40	1.20
Toggle Mini DPDT (17TOGDD-M)	$1.55	1.35

POTENTIOMETERS

	1-9	10-99	100+
Cermet (STS Series)	85¢	75¢	65¢
Multiturn (MTT Series)	85¢	75¢	55¢
Panel Mount (PMA Series)	$1.15	80¢	70¢

Standard Values Available

TERMS: Min. $20 + shipping. School Purchase Orders, VISA/ MC, Money Order, Prepaid. NO PERSONAL CHECKS, NO COD. NJ Residents: Add 7% Sales Tax.

In NJ: 732-381-8020
FAX: 732-381-1006
900 Hart St • Rahway, NJ 07065
800-972-2225
http://www.elexp.com
email: electron@elexp.com

acquired from Radiotronix. The first products shipped in limited quantities are the TRM-915-DTS (formerly the Wi.232DTS-R), TRM-868-EUR (formerly the Wi.232EUR-R), and the TRM-915-R250 (formerly the Wi.232FHSS-250-R). Linx has also started shipping the DP1203 modules, as well as recertified versions of the DTS, EUR, and R250 modules.

Radiotronix was acquired by Linx in March 2012. Linx will support, manufacture, and continue development of the Wi.232DTS, Wi.232EUR, Wi.232FHSS, Wi.DP1203, and Wi.DP1205 product lines.

For more information, contact:
Linx Technologies
Web: **www.linxtechnologies.com**

POLAR HEART RATE RECEIVER

The Polar heart rate receiver from Parallax is a Polar WearLink compatible receiver capable of wirelessly receiving coded heart beat transmissions from the Polar WearLink+ heart rate sensor. With its standard servo interface pinout (Vss, Vdd, Sig), interfacing with this receiver is very simple. Upon receipt of a heart beat signal, a 15 ms pulse is sent on the signal pin. This receiver also features a longer reception distance, giving you added flexibility in your application.

Key features include:

- Receives coded or non-coded signals from Polar heart rate transmitters.
- 100 cm to 125 cm reception distance gives a greater range from the transmitting heart rate sensor.
- Long 15 ms pulse on received heart beat gives the processor ample time to sample a pulse.
- Interface connector is not preinstalled to give prototyping flexibility.
- Standard servo connector compliant for easy interfacing.

Price is $29.99.

POLAR WEARLINK + CODED HEART RATE SENSOR

Also available from Parallax is the Polar WearLink+ coded heart rate transmitter which monitors and then wirelessly transmits heart rate data from the chest strap to a Polar WearLink compliant receiver. This allows the wearer to monitor their heart rate and related bio-metric statistics. This transmitter can be paired with local gym exercise equipment if it is Polar WearLink compatible.

Key features include:

- Heart rate sensor wirelessly transmits heart rate without the need for conductive gel.
- Water-resistant up to 30 meters for use in extreme environments.

Continued on page 77

PBP3
PICBASIC PRO™ Compiler
Experimenter - $49.95
Silver Edition - $119.95
Gold Edition - $269.95
The industry-standard BASIC compiler for Microchip PIC® microcontrollers.
Multi-Seat Licensing
for Educational Institutions
Upgrade from
PICBASIC™ Compiler (PBC)
Download a FREE trial version now.
www.PBP3.com
microEngineering Labs, Inc. www.melabs.com 888-316-1753
PICBASIC and PICBASIC PRO are trademarks of Microchip Technology Inc. in the USA and other countries. PIC is a registered trademark of Microchip Technology Inc. in the USA and other countries.

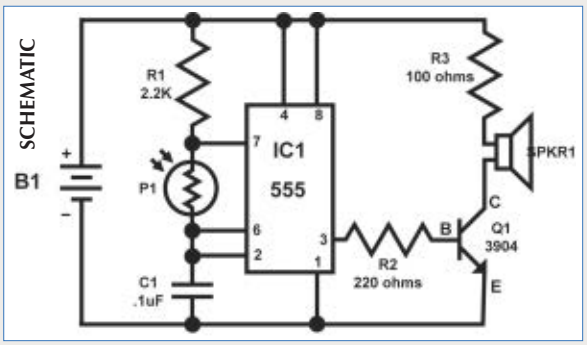
FUNDAMENTALS

CIRCUITS AND BASICS FOR THE BEGINNER

Build a Screaming Box

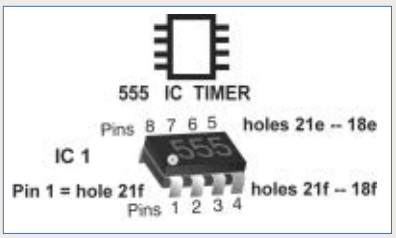
A kit for these experiments can be purchased from the *Nuts & Volts* Webstore at www.nutsvolts.com or call us at 800-783-4624.

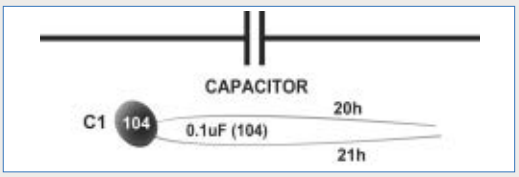
Use this simple light detector circuit to make a Screaming Box to use as a gag or to catch late-night snackers in the act!

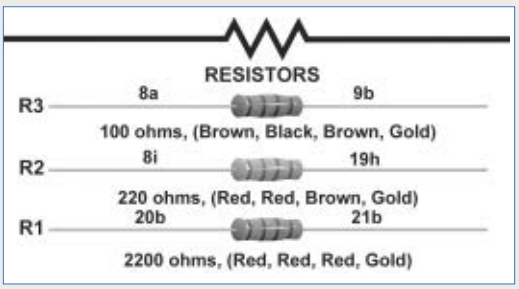


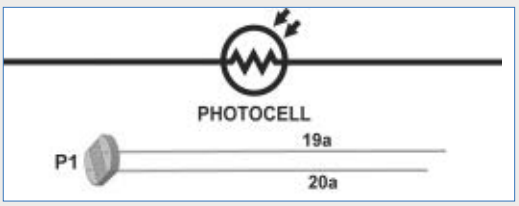
Build the Circuit. Using the schematic along with the pictorial diagram, place the components on a solderless breadboard as shown. Verify that your wiring is correct. **Do the Experiment.**

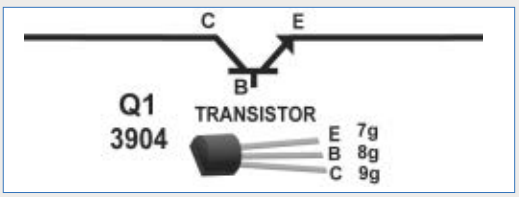
Theory: This project uses the 555 timer circuit as an astable multivibrator. The voltage across the photocell controls the frequency of the pulses coming from pin 3 of the 555. Transistor Q1 amplifies the pulses and sends them to the speaker. The more light that hits the photocell, the lower the resistance and therefore the higher the frequency of the tone emitted from the speaker. **Procedure:** Connect a nine volt battery to the battery snap. You should hear an approx. 500 Hz tone coming from the speaker. If you decide to place the circuit in an enclosure of some type (or hide it in a cookie jar), remember to detach the circuit from the battery when not in use because it will drain the battery. (When using the circuit in an enclosure, you may still hear a small buzz sound even when you have the photocell completely covered.)

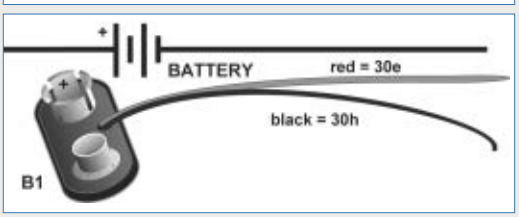






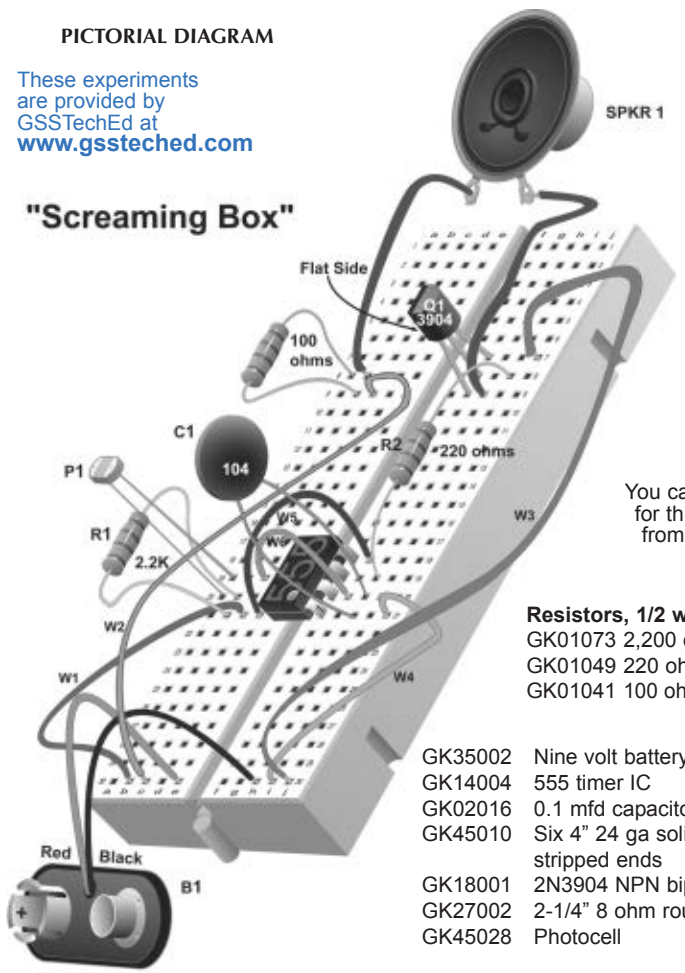






PICTORIAL DIAGRAM

These experiments are provided by GSSTechEd at **www.gssteched.com**

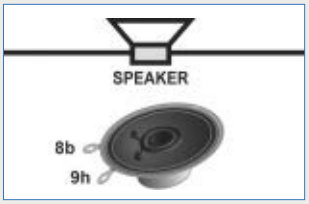


You can order parts for this experiment from their website as follows:

Resistors, 1/2 watt 5%
GK01073 2,200 ohms (R1)
GK01049 220 ohms (R2)
GK01041 100 ohms (R3)

GK35002	Nine volt battery snap
GK14004	555 timer IC
GK02016	0.1 mfd capacitor
GK45010	Six 4" 24 ga solid wires, stripped ends
GK18001	2N3904 NPN bipolar transistor
GK27002	2-1/4" 8 ohm round speaker
GK45028	Photocell

WIRES
W1 = 21c and 30b
W2 = 9c and 30c
W3 = 7j and 30j
W4 = 21j and 30i
W5 = 21d and 18g
W6 = 19d and 20g



CLASSIFIEDS

KITS/PLANS

High Quality
Electronic Kits & Modules

$59.95
UK1133

50 AMP DIGITAL PWM
(OPTIONAL DISPLAY)

FM Transmitters
Timers
Audio Amplifiers
Motor Controllers
PIC Programmers / Arduino

• • • Custom Designs • • •

www.canakit.com

Electronic Kits

- Fun and Educational
- Discount White and Blue LEDs
- Quantity Discounts

www.bakatronics.com

QKITS.COM

50 AMP PWM

1-888-GO 4 KITS

ENERGY SOLUTIONS

Save Money On
Your Electric Bill
www.sunny-solutions-shop.com
800-315-0309

HARDWARE WANTED

DEC EQUIPMENT WANTED!!!
Digital Equipment Corp.
and compatibles.
Buy - Sell - Trade
CALL KEYWAYS 937-847-2300
or email buyer@keyways.com

LIGHTING

ROBOTICS

The HRLV- MaxSonar Sensors

- Amazing One-Millimeter Resolution
- Simultaneous Multiple Sensor Operation
- Superior Noise Rejection
- Target Size Compensation for Accuracy
- Temperature Compensation ($4.95)
- Outputs now include TTL Serial

$34.95 (MSRP)

www.MaxBotix.com

SURPLUS

SURPLUS ELECTRONIC PARTS & ACCESSORIES

Over 18,000 Items in Stock.

Cables, Connectors, Displays, Fans
Hardware, LEDs, Motors, Potentiometers
Relays, Semiconductors, Service Manuals, Speakers
Switches, Test Equipment, Tools, VCR Parts

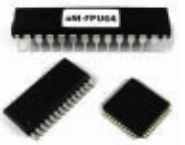
Surplus Material Components
SMC ELECTRONICS
www.smcelectronics.com

No Minimum Order.
Credit Cards and PAYPAL Accepted.
Flat $4.95 per order USA Shipping.

COMPONENTS

RF PARTS™ CO.
Tubes, Transistors, Power Components
Email: rfp@rfparts.com • Web: www.rfparts.com
800-737-2787 Fax 888-744-1943

New
uM-FPU64
64-bit Floating Point Coprocessor



DIP-28, SOIC-28,TQFP-44

64-bit and 32-bit IEEE 754 compatible
SPI or I2C interface, 3.3V Supply, 5V Tolerant I/O
Extensive floating point support, FFT, matrix operations
GPS input, local device support, Flash functions, IDE

Robotics
Navigation
Sensor Modules
Embedded Systems

Additional products...
uM-FPU V3.1 32-bit FPU
uM-PWM1 Servo Coprocessor

www.micromegacorp.com

ENGINEERING/ DESIGN SERVICES

DEVELOTECH, INC.
IP, PCB & Circuit Design,
Firmware, Smart Sensors,
Test, Low Quantity Builds
NV@DEVELOTECH.NET
Orlando, FL 407.756.6823

Circuit board layouts
Prototype assemblies
WWW.OSPREYELECTRONICS.COM
Convert your sketch or print into a quality pcb for a reasonable price. Visit us on the web or call Osprey Electronics at (208) 664 1089 (USA)

Proto Buddy Book & Kit Combo

For complete details visit our webstore @ www.nutsvolts.com

Continued from page 75

- Coded transmission prevents cross-talk from other noisy devices.
- Battery to last up to 2,000 hours of continuous usage.
- Adjustable elastic strap for comfortable (yet secure) sensing.
- Removeable and machine-washable textile strap keeps sensor bacteria free.

Price is $49.99.

For more information, contact:
Parallax, Inc.
Web: **www.Parallax.com**

READER-TO-READER TECHFORUM

>>> QUESTIONS

Modify Scott 340A Tube Receiver

I live very close to a huge water tank that affects stereo reception. I would like to connect a scope to measure FM multipath distortion. I have had no luck getting help from user groups, etc., so far! Does anyone know exactly how to do this? I can't afford the McIntosh tuners. I can do the construction if I had a schematic. Is this possible?

#7121 **Nick Oshana**
Bristol, CT

Timer Needed

I need a 2-3 second timer to operate a 24 volt relay, to open and close a garage door using a Desa Int'l wireless doorbell.

#7122 **James Moore**
via email

Fiber Optic Fusion Splicer

I am looking for some technical information for repairing various fusion splicers on the market such as Fitel, Sumitomo, and Fujikura. Anybody have any information they are willing to share?

#7123 **Walter**
Glendale, AZ

Garage Door Sensor

What's the best way to hack the garage door sensor so that when the garage door is open, anything breaking the light beam will trip a relay?

#7124 **Kenneth Lysek**
Henderson, CO

CCD/CMOS Camera Back

One of my deepest desires has been to "resurrect" my film cameras as digital. Is it at all feasible to construct some sort of relatively compact and usable CMOS or CCD device which can be attached to an existing camera that would yield high resolution images to be stored on a standard memory card? If so, could a diagram and list of materials be provided? I would prefer a full format sensor for use on a full format 35 mm camera, but a smaller format sensor would be acceptable for attachment to microscopes or telescopes.

#7125 **Greg Bargis**
Baltimore, MD

Schematics and Components

I don't know that much about reading circuit diagrams, but in theory, if I bought all the components in a given diagram, could I simply connect each component to the others as shown in the schematic? I have seen reference to using a breadboard but from what little I've read, they are configured in various ways and I wouldn't know what configuration a given project might require.

I understand that soldering component leads together with no substructure or framework might look like a piece of modern art, but could I do that and expect it to do what it is supposed to — whatever that is?

#7126 **M. D. Calvert**
Oak Ridge, TN

RF Chip for Fuel Tank

Has anyone heard of a RF chip which attaches to the fuel tank of a vehicle and supposedly provides high frequency output which increases fuel mileage?

#7127 **CWS**
via email

>>> ANSWERS

[#5125 - March 2012]
Looking For Datasheets

I have a collection of one and two Meg memory strips from early PCs, with which I would like to make delay lines for digitized audio. I can find no application or pin-out data for the chips; the markings seem inconsistent from strip to strip, and have no manufacturer's name or logo. (I have one set of what I believe to be four Meg strips designated as MT4C4ME8DJ.) I've done Google searches for this style of memory chip to no avail. Can anyone help?

This is an old EDO SIMM.

Knowing that — and knowing that MT meant Micron — I did a Google search for "micron edo memory datasheet" and found: **www.pjrc.com/mp3/simm/datasheet.html** which says (among other things):

4, 8 MEG x 32 DRAM SIMMs
(OBSOLETE)
DRAM MODULE
MT8D432(X)
MT16D832(X)

FEATURES

- JEDEC- and industry-standard pin-out in a 72-pin, single in-line memory module (SIMM)
- 16 MB (4 Meg x 32) and 32 MB (8 Meg x 32)

All questions *AND* answers are submitted by *Nuts & Volts* readers and are intended to promote the exchange of ideas and provide assistance for solving technical problems. Questions are subject to editing and will be published on a space available basis if deemed suitable by the publisher. Answers are submitted by readers and **NO GUARANTEES WHATSOEVER** are made by the publisher. The implementation of any answer printed in this column may require varying degrees of technical experience and should only be attempted by qualified individuals.

Always use common sense and good judgment!

Send all questions and answers by email to **forum@nutsvolts.com**
*Check at **www.nutsvolts.com** for tips and info on submitting to the forum.*

- High performance CMOS silicon-gate process
- Single 5V ±10% power supply
- All inputs, outputs, and clocks are TTL-compatible
- Refresh modes: RAS#-ONLY, CAS#-BEFORE-RAS# (CBR), and HIDDEN
- 2,048 cycle refresh distributed across 32 ms
- Fast Page Mode (FPM) access or Extended Data-Out (EDO) Page Mode access

OPTIONS

Options	Marking
Timing	
50 ns access	-5*
60 ns access	-6
Packages	
72-pin SIMM	M
72-pin SIMM (Gold)	G
Operating Modes	
FAST PAGE MODE	None
EDO PAGE MODE	X

*EDO version only

Part Numbers

EDO Operating Mode

Part Number	Configuration	Plating
MT8D432G- x X	4 Meg x 32	Gold
MT8D432M- x X	4 Meg x 32	Tin/Lead
MT16D832G-x X	8 Meg x 32	Gold
MT16D832M-x X	8 Meg x 32	Tin/Lead

x = speed

FPM Operating Mode

Part Number	Configuration	Plating
MT8D432G-x	4 Meg x 32	Gold
MT8D432M-x	4 Meg x 32	Tin/Lead
MT16D832G-x	8 Meg x 32	Gold
MT16D832M-x	8 Meg x 32	Tin/Lead

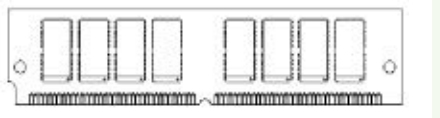
x = speed

For the latest datasheet revisions, please refer to the Micron website: **www.micron.com/mti/msp/html/datasheet.html**.

If this isn't the right part, then try **www.alldatasheet.com/view.jsp?Searchword=MT4C4ME8**.

Rusty Carruth
via email

Pin Assignment (Front View)
72-Pin SIMM
4 Meg x 32
8 Meg x 32



PIN	SYMBOL	PIN	SYMBOL	PIN	SYMBOL	PIN	SYMBOL
1	Vss	19	A10	37	NC	55	DQ12
2	DQ1	20	DQ5	38	NC	56	DQ28
3	DQ17	21	DQ21	39	Vss	57	DQ13
4	DQ2	22	DQ6	40	CAS0#	58	DQ29
5	DQ18	23	DQ22	41	CAS2#	59	Vdd
6	DQ3	24	DQ7	42	CAS3#	60	DQ30
7	DQ19	25	DQ23	43	CAS1#	61	DQ14
8	DQ4	26	DQ8	44	RAS0#	62	DQ31
9	DQ20	27	DQ24	45	NC/RAS1#*	63	DQ15
10	VDD	28	A7	46	NC	64	DQ32
11	NC	29	NC (A11)	47	WE#	65	DQ16
12	A0	30	VDD	48	NC	66	NC
13	A1	31	A8	49	DQ9	67	PRD1
14	A2	32	A9	50	DQ25	68	PRD2
15	A3	33	NC/RAS3#*	51	DQ10	69	PRD3
16	A4	34	RAS2#	52	DQ26	70	PRD4
17	A5	35	NC	53	DQ11	71	NC
18	A6	36	NC	54	DQ27	72	Vss

*32 MB version only

[#6122 - June 2012]
VHF Receiver

#1 *Does anyone know of a VHF receiver that will tune in AM/SW signals after they've been frequency shifted up to the 216-302 MHz range? I would like to isolate the 500 kHz - 22 MHz band from a directional AM/SW antenna and use a local oscillator to raise them to 216-237.5 MHz. Then, I'd like to do the same for three other directional antennas to end up with four intermediate frequencies ranging from 216-302 MHz. I'm worried that a typical VHF tuner will only look for FM signals — of the wrong channel width — within the VHF band. These four new intermediate frequencies will now be high enough to make it through amplifiers (usually limited to 54-894 MHz) on our local cable system. I know that a local oscillator could be used at the receiver to bring them back down to their original range for use with a regular AM/SW radio, but I'm looking for an off-the-shelf solution without a hardware modified receiver. Can the "Uniden Home Patrol" or "GRC PSR-800" receivers have their Flash memory store software modified to do this? The four separate intermediate frequencies will give the end user access to their choice of signals from four different directions. Something low cost, with an internal power supply (no wall warts), and include digital or SSB would be ideal. Thanks.*

Your shortwave distribution via cable TV sounds most interesting!

I have reviewed the specs for the PSR-800 and Uniden Home Patrol receivers and find them to be less than ideal for your purpose.

1) The channel step size for these receivers is 6.25 kHz for the PSR-800 and 5 kHZ for the Uniden. Many longwave and shortwave stations are best resolved on 1 kHz or 9 kHz channel steps or smaller. Your listeners will not be able to tune in all stations.

2) The AM channel bandwidth for these types of receivers is in the order of 12 to 15 kHz which means that several stations may be heard at once.

Most shortwave receivers offer a 3 or 6 kHz filter bandwidth to better resolve shortwave stations.

A receiver such as the AOR8200 MK3 or one of its desktop equivalents, or one of the ICOM professional receivers such as the ICR-8500 (now obsolete) would be a suitable receiver and will permit CW, USB, and LSB reception.

You mentioned the use of a local oscillator as a down converter at the receiving end to facilitate use of a standard shortwave receiver. This would be an excellent option as you could use the frequency selector knob of the LO to directly steer your directional antenna selection (N,E,W,S) without having to retune the receiver. This would be functionally a superior method. Secondly, the use of a down converter frees the listener from having to calculate the LO offset used for each frequency and directional antenna.

The selection of shortwave receiver should be models which permit direct connection of an external antenna (the down converter output). In this way, interference from over the air signal to the cable provided signal can be minimized. There will be a delay, and resulting tone difference between signals leaking in from over the air and those of the cable system, so use of well shielded coax is recommended.

Something you should consider is that the TV channels on the cable system are generally adjusted so that their amplitude is equal on each channel to minimize reception of inter-modulation (IM - channel mixing) artifacts on television channels. Your shortwave channel will demand a larger dynamic range to receive weaker shortwave stations, so it is possible that IM products from the TV channels will be heard within the shortwave pass band. Likewise, the shortwave signals presented to the head end will have to be adjusted so that the aggregate power (in a 6 MHz channel bandwidth) does not exceed that of the channel power of the TV channels, or TV reception may be bothered.

You might also consider use of an FM modulated up converter and FM demodulator/down converter method where the 500 kHz to 22 MHz "base band" is directly applied to an FM modulator and recovered from a demodulator at the receiver. You may be able to find some suitable commercially available CATV FM video modulators and demodulators that will interface directly at the head end.

I experimented with this technique over an FM microwave link and it worked well, and because the base band is faithfully demodulated, there was no frequency translation error in the recovered signal.

Good luck on this project. I would be interested in hearing how it works out.

Joe Leikhim
Communications Consultant
Oviedo, FL

#2 My Realistic PRO 2004 allows the selection of AM detection at any time, and those receivers can be found on eBay for a pretty low price these days. You would be stuck with a fixed frequency step and no BFO, but that's probably fine for listening to foreign broadcasts. Another approach is a software-defined radio like the Funcube Dongle. That will require a computer, but it is really flexible and there's amazing free software, too. I'm surprised that you have that kind of directionality for such a wide frequency range; I would think that two antennas would be about as good as you can do.

Charles Wenzel
Austin, TX

[#6123 - June 2012]
Digital Technology?

I am a senior citizen plagued with hearing loss. I have been using hearing aids for about 30 years!! The vendors keep touting "digital" technology although none of them can explain how "digital" amplifiers work. I am familiar with analog amplifiers. Can someone give an explanation of this "digital" technology?

A digital hearing aid still has an analog microphone, mic pre-amp, audio power amp and speaker (earpiece). It's what's in the middle that's digital: a programmable digital signal processor. The DSP takes the mic input and converts it to bits of data (digital). The DSP can analyze the data and make adjustments depending on the programming. For example, if you have a hearing loss at 2,000 Hz the audiologist can program a boost in your hearing aid at 2,000 Hz. If after some time your hearing becomes diminished overall, the audiologist can program a general boost of all the frequencies if needed. The DSP can make smart decisions to automatically reduce or eliminate feedback and background noise. The latter can help you understand conversations in a noisy room. The DSP can automatically adjust the volume too. After the DSP does all this processing, it converts the bits of data back to analog and sends it to the audio amp. The beauty of a digital hearing aid is that a single design can be programmed to be used by many people without changing the electronics. All you need to have customized is the ear mold to fit your ear. An audiologist connects the hearing aid to a laptop computer to program its many parameters. Take a look at **www.hearsource.com** to see an example of how you can program your own digital hearing aid. As always, don't underestimate the value provided by your audiologist. Consider self-programming as fine-tuning and let the audiologist determine your baseline. (I am not a hearing professional. Consult with your doctor and audiologist for expert advice.)

Rick Swenton
Bristol, CT

■ LOOK FOR ■ SEARCH FOR ■ FIND

Find your favorite advertisers here!

ADvertiser INDEX

AMATEUR RADIO AND TV
NightFire Electronics.....35
Ramsey Electronics, Inc. ...20-21

BATTERIES/CHARGERS
Cunard Associates 30

BUYING ELECTRONIC SURPLUS
Jaycar Electronics.....41
Weirdstuff Warehouse 30

CCD CAMERAS/VIDEO
Circuit Specialists, Inc. 82-83
Ramsey Electronics, Inc. ...20-21

CIRCUIT BOARDS
AP Circuits 27
Cunard Associates 30
Dimension Engineering.....8
ExpressPCB 40
Front Panel Express LLC 18
Futurlec 13
PCB Pool 63
R.E. Smith Inc. 26
Saelig Company Inc. 26

COMPONENTS
Cana Kit Corp. 62
Chaney Electronics 4
Electronix Express 74
Fun Gizmos 30
Futurlec 13
NightFire Electronics.....35
Noritake 13
SDP/SI 30

COMPUTER
Hardware
Noritake 13
Weirdstuff Warehouse 30

Microcontrollers / I/O Boards
Abacom Technologies 18
Bitscope 62
Fun Gizmos 30
microEngineering Labs.....75
MikroElektronika 3
Parallax, Inc. .....Back Cover
Pololu Robotics & Electronics....5

DESIGN/ENGINEERING/ REPAIR SERVICES
Cana Kit Corp. 62
ExpressPCB 40
Front Panel Express LLC 18
PCB Pool 63

DIGITAL OSCILLOSCOPES
Rigol Technologies.....30

DRIVE COMPONENT CATALOGS
SDP/SI 30

EDUCATION
Bitscope 62
Command Productions 29
Elkins Training.....13
Global Specialties 7
GSS Tech Ed 73
NKC Electronics 30
Poscope.....53

EMBEDDED TOOLS
NetBurner 2

ENCLOSURES
Front Panel Express LLC 18

EVENTS
AUVSI.....52

KITS & PLANS
Cana Kit Corp. 62
Chaney Electronics 4
GSS Tech Ed 73
Jaycar Electronics.....41
NetBurner 2
NightFire Electronics.....35
NKC Electronics 30
QKITS.....30
Ramsey Electronics, Inc. ...20-21

MISC./SURPLUS
All Electronics Corp. 19
Chaney Electronics 4
Front Panel Express LLC 18
Weirdstuff Warehouse 30

OPTICS
Noritake 13

PROTOTYPING AND TRAINERS
Global Specialties 7

PROGRAMMERS
Futurlec 13
microEngineering Labs.....75
MikroElektronika 3

RF TRANSMITTERS/ RECEIVERS
Abacom Technologies 18

ROBOTICS
Fun Gizmos 30
GSS Tech Ed 73
Lemos International Co., Inc. ..30
Pololu Robotics & Electronics....5
Robot Power 30
SDP/SI 30

SATELLITE
Lemos International Co., Inc. ..30

TEST EQUIPMENT
Bitscope 62
Circuit Specialists, Inc. 82-83
Dimension Engineering.....8
Electronic Design Specialists.....9
Global Specialties 7
Jaycar Electronics.....41
NKC Electronics 30
Poscope.....53
Rigol Technologies.....30
Saelig Company Inc. 26

TOOLS
MikroElektronika 3
NetBurner 2
PanaVise 27
Poscope.....53

WAVEFORM GENERATORS
Rigol Technologies.....30

Abacom Technologies 18
All Electronics Corp. 19
AP Circuits 27
AUVSI 52
Bitscope 62
Cana Kit Corp. 62
Chaney Electronics 4
Circuit Specialists, Inc. 82-83
Command Productions 29
Cunard Associates 30
Dimension Engineering.....8
Electronic Design Specialists.....9
Electronix Express 74
Elkins Training.....13
ExpressPCB 40
Front Panel Express LLC 18
Fun Gizmos 30
Futurlec 13
Global Specialties 7
GSS Tech Ed 73
Jaycar Electronics.....41
Lemos International Co., Inc. 30
microEngineering Labs 75
MikroElektronika 3
NetBurner 2
NightFire Electronics.....35
NKC Electronics 30
Noritake 13
PanaVise 27
Parallax, Inc. .....Back Cover
PCB Pool 63
Pololu Robotics & Electronics.....5
Poscope.....53
QKITS 30
Ramsey Electronics, Inc. 20-21
R.E. Smith Inc. 26
Rigol Technologies.....30
Robot Power 30
Saelig Company Inc. 26
SDP/SI 30
Weirdstuff Warehouse 30

Programmable DC Electronic Load 0~80V / 0~40A

The 3721A Programmable DC Electronic Load provides excellent performance with sophisticated features found on much more expensive units. This 400 watt, 40 Amp, 0~80 volt Programmable DC Electric Load can be used to test all sorts of DC power sources including power supplies and is especially helpful to battery manufacturing processes. This DC load features constant voltage, constant resistance, constant current and constant power settings. The end user can design programs that control precisely all of the load values and time durations for each step of a test sequence. Up to nine 10 step programs can be internally stored in the 3721A Programmable DC Load.

- **4 basic functions: CC, CV, CR & CP**
- **8 basic test modes: CCL, CCH, CV, CRL, CRM, CRH, CPV & CPC**
- **Minimum operating voltage is less than 0.6v at the load's full rated current.**
- **High-speed sequence, high-speed transient, short circuit, battery discharge and other functions.**
- **Programable current slew rate.**
- **Multiple groups of parameters and lists can be saved & recalled.**
- **Supports SCPI and LabView with included software.**
- **Current Rating: 0~40A**
- **Voltage Rating: 0~80V**
- **Power Rating: 400W at 40°C**

Item#
CSI3721A **$720.00**

www.CircuitSpecialists.com/CSI3721A

Programmable DC Electronic Loads

Thease devices can be used with supplies up to 360VDC and 30A. It features a rotary selection switch and a numeric keypad used to input the maximum voltage, current and power settings. These electronic DC loads are perfect for use in laboratory environments and schools, or for testing DC power supplies or high-capacity batteries. It also features memory, and can also be connected to a PC, to implement remote control and supervision.

360V/150W (CSI3710A) $349.00
www.circuitspecialists.com/csi3710a

360V/300W (CSI3711A) $499.00
www.circuitspecialists.com/csi3711a

60 Watt Digital Soldering Station

For use with traditional or Lead Free Soldering

The CSI-Station-3DLF is a powerful 60 watt soldering system. The fast heat recovery provided by a 60 watt system like this allows the user to solder both traditional solder and lead free solder. This system features a grounded tip to protect delicate circuits from static charge. Specific system temps can also be set with an easy to use push button up/down button AND when you turn off this station, the unit keeps the last used temperature in memory & automaticly returns to that setting the next time the user turns the system on.Also included is a seperate iron holder. Circuit Specialists stocks a large supply of tips for this station.

Features:

- 60 watt dual core ceramic heater
- 150 to 450 degree Celsius Temperature range
- 302 to 896 degree Fahrenheit Temperature range
- Versatile easy to read liquid crystal display
- 3 preset & user definable temperature settings.
- Automaticly remembers previous temperature setting
- Display in Celsius or Fahrenheit scale
- 3 foot cord length from station to iron tip
- Broad selection of replacement tips available

Item#
CSI-Station-3DLF **$49.00**

www.CircuitSpecialists.com/CSI-Station-3DLF

SMD Hot Air Rework Station with Suction Pick-Up Wand

What every shop or lab needs to deal with todays SMT designed circuit boards. O.E.M. manufactured just for Circuit Specialists Inc., so we can offer the best price possible! A multi-technology assembly and repair station. The heater and air control system is built-in and adjusted by the simple touch of the front keypad for precise settings. Temperature range is from 100°C to 480°C / 212°F to 896°F, and the entire unit will enter a temperature drop state after 15 minutes of non-use for safety and to eliminate excessive wear.

Item#
CSI825A **$109.00**

www.CircuitSpecialists.com/CSI825A

SMD Hot Air Rework Station with Soldering Iron

An SMT rework station & soldering station in one handy unit! Perfect for shops & labs dealing with todays SMT board designs.O.E.M. manufactured just for Circuit Specialists Inc., so we can offer the best price possible! This multi-purpose station is perfect for all your surface mount and thru-hole requirements. The soldering iron has a grounded tip for static sensitive parts and uses a ceramic heating element for fast heat up and stable temperature control. A seperate aluminum constructed soldering iron holder is included.

Item#
CSI906 **$109.00**

www.CircuitSpecialists.com/CSI906

Heavy Duty PCB Cutting Shear

This PCB cutter is a terrific cutting tool for printed circuit boards, thin aluminum, plastic or copper. Cut fiberglass or paper phenolic pcbs up to 2mm thick. The powerful E-Z pull handle provides extreme leveredge through its unique design. A plastic safety guard is implemented to avoid cutting accidents. The upper and lower blades are manufactured from hardened alloyed tool grade steel and provide a precise well finished cut every time. A ruler affixed to the cutting platform ensures accurate cutting. This is a heavy duty, rugged shop grade pcb cutter.

PCB Cutter Ttechnical Data:

Board size : up to 320mm (about 12 ")
Cutting thickness: up to 2mm
Panel size:51×31.5mm²
Machine size:53×33×30mm³
Net weight:17.5Kg
Grose weight: 21Kg

Item#
PCB Cutter **$399.00**

www.CircuitSpecialists.com/pcb-cutter

Data Logging True RMS Digital Multimeter

The DM620 data-logging meter features auto ranging and has an auto shut down feature that extends battery life when the unit is left powered up. It also features Range Hold, Data Hold, and an audible continuity function. Besides the True-RMS AC and DC measurement modes for both voltage and current, it also features Resistance, Capacitance, and temperature measurements, along with a diode test function and the ability to measure the Frequency, Period, and Duty cycle of signals up to 10 Mhz.

- Data Logging: 18,000 Points & 50,000 Counts without attaching to a PC
- USB Interface (USB Cable & USB AC Charger Included)
- Basic Accuracy: 0.05% DC V
- True RMS
- Auto Calibration
- Trend Plot
- Real Time Clock
- 10 MHz Frequency Counter
- Record, Relative, Compare & Period Modes

Item#
DM620 **$139.00**

www.CircuitSpecialists.com/DM620

We carry a LARGE selection of Power Supplies, Soldering Equipment, Test Equipment, Oscilloscopes, Digital Multimeters, Electronic Components, Metal and Plastic Project Boxes, Electronic Chemicals, PC Based Digital I/O Cards, Panel Meters, Breadboards, Device Programmers, and many other interesting items. Check out our website at:

www.CircuitSpecialists.com

Step Up/Down Transformers

Step Up/Down Transformers

2 outlets: 1 for 110/120VAC
1 for 220/240VAC

Provides:
110/120VAC to 220/240VAC
or 220/240VAC to 110/120VAC

Heavy duty transformer design for safety & reliability

With either 110VAC or 220VAC input

300 Watt Step Up/Step Down Transformer
Item # **ST-300 $17.95**
www.circuitspecialists.com/ST-300

1500 Watt Step Up/Step Down Transformer
Item # **ST-1500 $53.00**
www.circuitspecialists.com/ST-1500

Step Up transformers

Allows users to acquire 220 VAC output with 110 VAC input.

Reliable heavy duty linear transformer design.

Universal 3 pronged style 220 VAC receptacles.

Integrated wire carry handles for added convenience.

200 Watt Step Up Transformer
Item # **TS-200 $9.95**
www.circuitspecialists.com/TS-200

1000 Watt Step Up Transformer
Item # **TS-1000 $29.95**
www.circuitspecialists.com/TS-1000

Digital Multimeter with Mechanically Protected Inputs

This is a terrific low cost digital multimeter from Circuit Specialists. IDEAL for students and technicians with a broad selection of measurement ranges and features. The Inputs are mechanically protected to PREVENT incorrect test lead placement (the leading cause of damage to digital multimeters). As the user moves the range selector, the inputs that are not appropriate to the set range are blocked while the appropriate inputs are opened. This makes it impossible to mis apply the test lead settings and makes using this digital multimeter easier and safer.

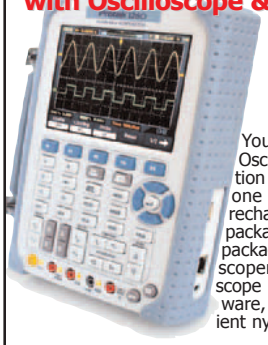
- 3 1/2 LCD display
- Overload protected
- Auto power off function
- data hold function
- Shock Resistant Case
- mechanicaly protected Inputs
- 2000uF test function
- Transistor test

Item # **CSI2012L**

$18.95

www.circuitspecialists.com/CSI2012L

200MHz Hand Held Scopemeter with Oscilloscope & DMM Functions



Includes 1 Year USA Warranty

You get both a 200 MHz Oscilloscope and a multi function digital multimeter, all in one convenient lightweight rechargeable battery powered package. This power packed package comes complete with scopemeter, test leeds, two scope probes, charger, PC software, USB cable and a convenient nylon carrying case.

- 200MHz Handheld Digital Scopemeter with integrated Digital Multimeter Support
- 200MHz Bandwidth with 2 Channels
- 500MSa/s Real-Time Sampling Rate
- 50Gsa/s Equivalent-Time Sampling Rate
- 6,000-Count DMM resolution with AC/DC at 600V/800V, 10A
- Large 5.7 inch TFT Color LCD Display
- USB Host/Device 2.0 full-speed interface connectivity
- Multi Language Support
- Battery Power Operation (Installed)

Item # **DSO1200** *New Low Price!* **$589.00**

www.circuitspecialists.com/DSO1200

60MHz Hand Held Scopemeter with Oscilloscope & DMM Functions

- 60MHz Handheld Digital Scopemeter with integrated Digital Multimeter Support
- 60MHz Bandwidth with 2 Channels
- 150MSa/s Real-Time Sampling Rate
- 50Gsa/s Equivalent-Time Sampling Rate
- 6,000-Count DMM resolution with AC/DC at 600V/800V, 10A
- Large 5.7 inch TFT Color LCD Display
- USB Host/Device 2.0 full-speed interface connectivity
- Multi Language Support
- Battery Power Operation (Installed)

Item # **DSO1060** *New Low Price!* **$429.00**

www.circuitspecialists.com/DSO1200

60MHz Hand Held Scopemeter w/Oscilloscope, DMM Functions & 25 MHz Arbitrary Waveform Generator

- All the features of the DSO1060 plus a 25 MHz Arbitrary Waveform Generator.
- Waveforms can be saved in the following formats: jpg/bmp graphic file, MS excel/word file
- Can record and save 1000 waveforms
- DC to 25 MHz Arbitrary Waveform Generator

Item # **DSO-8060** *New Low Price!* **$519.00**

www.circuitspecialists.com/DSO-8060

Programmable DC Power Supplies

- Up to 10 settings stored in memory
- Optional RS-232, USB, RS-485 adapters
- May be used in series or parallel modes with additional supplies.
- Low output ripple & noise
- LCD display with backlight
- High resolution at 1mV

Model	CSI3644A	CSI3645A	CSI3646A
DC Voltage	0-18V	0-36V	0-72V
DC Current	5A	3A	1.5A
Power (max)	90W	108W	108W
Price	**$199.00**	**$199.00**	**$199.00**

www.circuitspecialists.com/csi-power-supplies

Hantek 5000B Series Digital Storage Oscilloscopes

Introducing the Hantek 5000B Series Digital Storage Oscilloscopes. Available in 60MHz, 100MHz and 200MHz Bandwidths. Each one provides a 1GSa/s real-time sample rate. In addition, they have a 1M memory depth for better observation of waveform details. The 7 inch color TFT LCD Display with Windows-style interface and menus provide easy operation.

Abundant menu information and easy-to-use buttons give you plenty of measurement information:

The multifunctional knobs and the powerful shortcut keys help save time during operation.

The Autoset function lets you detect sine and square waves automatically.

The Probe Check Wizard guides you to adjust the probecompensation and set the Probe option attenuation factor.

Three help methods (context-sensitive, hyperlinks, and an index).

You can quickly master all functions to greatly improve your efficiency in production and development.

Features:
- **60, 100 or 200 MHz** bandwidth
- **1GSa/s** Real Time sample rate
- **25GSa/s** Equivalent sample rate
- Large (7.0-inch) color display,WVGA(800x480)
- Record length **1M**
- Trigger modes: edge/pulse width/line selectable video/slop/overtime etc.
- USB host and device connectivity, standard
- Multiple automatic measurements
- Four math functions, including FFTs standard
- Provides software for PC real-time analysis

New Lower Introductory Prices!

3 Models to choose from

DSO5062B 60MHz Digital Storage Oscilloscope

~~$385.00~~ **$369.00***

www.circuitspecialists.com/dso5062b.html

DSO5102B 100MHz Digital Storage Oscilloscope

~~$499.00~~ **$399.00***

www.circuitspecialists.com/dso5102b.html

DSO5202B 200MHz Digital Storage Oscilloscope

~~$599.00~~ **$499.00***

www.circuitspecialists.com/dso5202b.html

*Discount does not apply to prior sales.

Join Parallax at an event near you!

Learn and explore with Parallax microcontrollers and robotics at an event this Summer.

DATE	EVENT TYPE	EVENT NAME	CITY & STATE
06/23/12	Public Event	Unofficial Propeller Expo Chicago (UPEC)	Lombard, IL
07/09 - 07/12/12	Teachers Only	ARRL Teachers Institute on Wireless Technology	Rocklin, CA
08/01 - 08/02/12	Teachers Only	FREE BASIC Stamp Educator's Course	Rocklin, CA
08/03/12	Teachers Only	FREE Propeller Educator's Course	Rocklin, CA
08/11/12	Public Event	Robot Weekend @ Sacramento Discovery Museum	Sacramento, CA
09/29/12	Scouting Event	Boy Scouts Expo	Beale Air Force Base, CA
09/29/12	Public Event	World Maker Faire New York	Queens, NY

Parallax Educator's Courses

Tech Lit is our favorite subject! Our microcontroller immersion workshops equip teachers with electronics, programming, and robotics experience to enhance any STEM (science, technology, education, mathematics) program. The BASIC Stamp course covers the elements of inventing and robotics with simple electronic components. The Propeller course shows how quickly and easily complex projects can be built with this multicore microcontroller.
Note: Open to high school, community college, university, and vocational-technical school instructors only.

Photo courtesy: 2012 © copyright Rich Harman.

For more details or to sign up for a Parallax event: www.parallax.com/events. Order online or call us toll-free at 888-512-1024 (M-F, 8am-5pm, PDT).

Friendly microcontrollers, legendary resources.™

Prices are subject to change without notice. BASIC Stamps is a registered trademark of Parallax Inc. Propeller, Parallax and the Parallax logo are trademarks of Parallax Inc.

PARALLAX INC

"ParallaxInc" on Twitter, Facebook, and YouTube